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Outline Planning Consultants Pty ltd

Gulgong Quarry Project

Air Quality Assessment

70B-24-0362-TRP-78432-0

9 August 2024

Job Title:	Gulgong Quarry Project
Report Title:	Air Quality Assessment
Document Reference:	70B-24-0362-TRP-78432-0

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Revision History:

Rev. #	*Comments / Details of change(s) made*	*Date*	*Revised by:*
Rev. 00	Original issue	9 August 2024	

Executive Summary

Vipac Engineers and Scientists Ltd was engaged by Outline Planning Consultants Pty Ltd on behalf of Sheridan's Hamish and Sally Drury (the Proponent) to prepare an air quality assessment to support a development consent application for a quarry at Tallawang NSW, otherwise known as 'Gulgong Quarry'. The Proponent proposes development of the hard rock quarry with quarry footprint totalling approximately 7.34ha, a total resource of approximately 4.6 million tonnes and a proposed extraction rate of up to 350,000 tonnes per annum. It is anticipated that the quarry will generate an average of 35 loaded trucks per day, generating up to 60 loaded quarry trucks per day.

The purpose of this assessment is to evaluate the potential impacts of air pollutants generated from the introduction of the quarry at the project site and to provide recommendations to mitigate any potential impacts that might have an effect on any sensitive receptors, where applicable.

The air quality impact assessment has been carried out as follows:

- An emissions inventory of TSP, PM_{10}, $PM_{2.5}$, and deposited dust for the proposed maximum daily activities associated with the Project was compiled using National Pollutant Inventory (NPI) and United States Environmental Protection Agency (USEPA) AP-42 emissions estimation methodology.
- Estimated emissions data was used as input for air dispersion modelling. The modelling techniques were based on a combination of The Air Pollution Model (TAPM) prognostic meteorological model (developed by CSIRO), and the CALMET model suite used to generate a three dimensional meteorological dataset for use in the CALPUFF dispersion model.
- The atmospheric dispersion modelling results were assessed against the air quality assessment criteria as part of the impact assessment. Air quality controls are applied to reduce emission rates where applicable.

As summarised in Table ES-1 and Table ES-2, the results of the modelling have shown that the TSP, PM_{10}, $PM_{2.5}$ and dust deposition predictions comply with the relevant criteria and averaging periods at all sensitive receptors modelled for the Project in isolation.

TSP, dust deposition and annual average PM_{10} and $PM_{2.5}$ predictions are also less than criteria for the Project including background at all modelled sensitive receptors. Whilst the 24-hour average PM_{10} and $PM_{2.5}$ predictions are above, the exceedances are driven by the elevated background adopted for the assessment, which are already above or close to the criteria. No additional exceedances of the criteria at these receptors are predicted to occur as a result of the proposed quarry operations and that best management practices will be implemented to minimise emissions as far as is practical. In the absence of the elevated background therefore, we would anticipate no exceedances of the criteria. As specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, under these circumstances no additional assessment is therefore required at these receptors.

Emissions controls for dust abatement were included in the assessment. It should also be noted that some of the planned dust control measures are not easily quantifiable but will also still serve to reduce dust emissions. The dispersion modelling study has taken a conservative approach and have not incorporated the effectiveness of these controls in the development of the emissions inventory.

It is therefore concluded that air quality should not be a constraint for proposed quarry.

Table ES-1: Summary of Results – Project in Isolation

ID	Predicted Concentrations (µg/m³)					Dust deposition (g/m²/month)	Compliant
	PM_{10}		$PM_{2.5}$		TSP		
	24 h	Annual	24 h	Annual	Annual	Month	
SR1	20.04	0.45	4.41	0.09	0.34	0.074	✓
SR2	6.07	0.24	1.35	0.05	0.27	0.033	✓
SR3	1.04	0.03	0.22	0.01	0.23	0.005	✓
SR4	1.98	0.06	0.39	0.01	0.2	0.012	✓
SR5	2.31	0.05	0.47	0.01	0.13	0.011	✓
SR6	1.96	0.05	0.4	0.01	0.12	0.009	✓

ID	Predicted Concentrations (µg/m³)					Dust deposition (g/m²/month)	Compliant
	PM_{10}		$PM_{2.5}$		TSP		
	24 h	Annual	24 h	Annual	Annual	Month	
SR7	2.19	0.07	0.45	0.02	0.09	0.013	✓
SR8	1.9	0.07	0.39	0.02	0.05	0.013	✓
SR9	3.42	0.2	0.7	0.05	0.05	0.026	✓
SR10	4.5	0.29	0.96	0.07	0.04	0.053	✓
SR11	4.46	0.39	0.96	0.09	0.03	0.082	✓
SR12	0.91	0.03	0.19	0.01	0.03	0.002	✓
SR13	1.2	0.04	0.25	0.01	0.03	0.004	✓
SR14	2.09	0.06	0.43	0.01	0.03	0.007	✓
SR15	2.34	0.07	0.47	0.01	0.03	0.006	✓
SR16	1.67	0.07	0.32	0.02	0.03	0.009	✓
SR17	0.92	0.05	0.21	0.01	0.02	0.010	✓
SR18	1.47	0.08	0.3	0.02	0.02	0.015	✓
SR19	5.96	0.21	1.29	0.04	0.02	0.034	✓
SR20	2.1	0.06	0.42	0.01	0.02	0.017	✓
SR21	1.32	0.05	0.27	0.01	0.02	0.013	✓
SR22	1.58	0.06	0.33	0.01	0.02	0.012	✓
SR23	11.37	0.35	2.36	0.07	0.01	0.052	✓
SR24	6.55	0.28	1.47	0.06	0.01	0.047	✓
Criteria	**50**	**25**	**25**	**8**	**90**	**2**	

Table ES-2: Summary of Results – Cumulative

ID	Predicted Concentrations (µg/m³)					Dust deposition (g/m²/month)	Compliant
	PM_{10}		$PM_{2.5}$		TSP		
	24 h[a]	Annual	24 h[a]	Annual	Annual	Month	
SR1	69.44	14.65	31.51	4.79	35.84	2.07	✓
SR2	55.47	14.44	28.45	4.75	35.77	2.03	✓
SR3	50.44	14.23	27.32	4.71	35.73	2.00	✓
SR4	51.38	14.26	27.49	4.71	35.7	2.01	✓
SR5	51.71	14.25	27.57	4.71	35.63	2.01	✓
SR6	51.36	14.25	27.5	4.71	35.62	2.01	✓
SR7	51.59	14.27	27.55	4.72	35.59	2.01	✓
SR8	51.3	14.27	27.49	4.72	35.55	2.01	✓

ID	Predicted Concentrations (µg/m³)					Dust deposition (g/m²/month)	Compliant
	PM_{10}		$PM_{2.5}$		TSP		
	24 h[a]	Annual	24 h[a]	Annual	Annual	Month	
SR9	52.82	14.4	27.8	4.75	35.55	2.03	✓
SR10	53.9	14.49	28.06	4.77	35.54	2.05	✓
SR11	53.86	14.59	28.06	4.79	35.53	2.08	✓
SR12	50.31	14.23	27.29	4.71	35.53	2.00	✓
SR13	50.6	14.24	27.35	4.71	35.53	2.00	✓
SR14	51.49	14.26	27.53	4.71	35.53	2.01	✓
SR15	51.74	14.27	27.57	4.71	35.53	2.01	✓
SR16	51.07	14.27	27.42	4.72	35.53	2.01	✓
SR17	50.32	14.25	27.31	4.71	35.52	2.01	✓
SR18	50.87	14.28	27.4	4.72	35.52	2.01	✓
SR19	55.36	14.41	28.39	4.74	35.52	2.03	✓
SR20	51.5	14.26	27.52	4.71	35.52	2.02	✓
SR21	50.72	14.25	27.37	4.71	35.52	2.01	✓
SR22	50.98	14.26	27.43	4.71	35.52	2.01	✓
SR23	60.77	14.55	29.46	4.77	35.51	2.05	✓
SR24	55.95	14.48	28.57	4.76	35.51	2.05	✓
Criteria	**50**	**25**	**25**	**8**	**90**	**4**	

a. No additional exceedances of the 24 hour average PM10 and PM2.5 criteria are predicted to occur as a consequence of the proposed quarry operations. As specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, under these circumstances no additional assessment is therefore required at these receptors.

Table of Contents

1 Introduction

1.1 Overview

Vipac Engineers and Scientists Ltd (Vipac) was engaged by Outline Planning Consultants Pty Ltd on behalf of Hamish and Sally Drury (the Proponent) to prepare an air quality assessment to support a development consent application for a quarry at Tallawang NSW, on Lot 1 in Deposited Plan (DP) 1239728, which forms a part of a larger rural holding known as 'Talinga', No.1848 Castlereagh Highway Gulgong NSW 2852, otherwise known as 'Gulgong Quarry'. The Proponent proposes development of the hard rock quarry with quarry footprint totalling approximately 7.34ha, a total resource of approximately 4.6 million tonnes and a proposed extraction rate of up to 350,000 tonnes per annum (the Project).

The purpose of this assessment is to evaluate the potential impacts of air pollutants generated from the Project and to provide recommendations to mitigate any potential impacts that might have an effect on nearby sensitive receptors.

1.2 Study Objectives and Requirements

The NSW Environment Protection Authority (EPA) has considered the details of the proposal and has identified the information it requires for the Environmental Impact Statement (EIS). The key requirements specified in relation to air quality and how the requirements are addressed within this document are summarised in Table 1-1.

The purpose of this assessment is to evaluate the potential impacts of air pollutants generated from the Project which addresses the specific EPA requirements and provides recommendations to mitigate any potential impacts that might have an effect on nearby sensitive receptors.

Table 1-1: Summary of EAR

Requirements	How requirement is addressed
1. Identify all potential discharges of fugitive and point source emissions of pollutants including dust for all stages of the proposal and assess the risk associated with those emissions. All processes that could result in air emissions must be identified and described. Sufficient detail to accurately communicate the characteristics and quantity of all emissions must be provided. Assessment of risk relates to environmental harm, risk to human health and amenity.	An emissions inventory has been developed that takes into account dust generating activities from quarry activities and disturbed surfaces within the site boundaries (Section 6.1).
2. Justify the level of assessment undertaken on the basis of risk factors, including but not limited to: a. proposal location; b. characteristics of the receiving environment; c. type and quantity of pollutants emitted.	A quantitative air quality assessment is prepared in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2022). See Section 6.
3. Describe the receiving environment in detail. The proposal must be contextualised within the receiving environment (local, regional and inter-regional as appropriate). The description must include but need not be limited to: a. meteorology and climate; b. topography; c. surrounding land-use; d. ambient air quality.	The existing environment surrounding the project site is described in Section 5.
4. Include a consideration of 'worst case' emission scenarios and impacts at proposed emission limits.	The emissions inventory developed for the assessment accounts for potential worst-case or maximum quarry activities rather than average or typical daily activities (Section 6.1).

5. Account for cumulative impacts associated with existing emission sources as well as any currently approved developments linked to the receiving environment.	Cumulative impacts are accounted for by adopting background data from the nearest representative NSW EPA operated air quality monitoring station. As outlined in Section 5.3, this data includes elevated concentrations of PM10 and PM2.5 which are a consequence of bushfire smoke and/or dust storms and are already above or approaching relevant air quality criteria. These are therefore considered to be an overestimation of background pollutant concentrations at the project site. Nevertheless, they are included in the assessment in accordance with the requirements specified in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW.
6. Include air dispersion modelling where there is a risk of adverse air quality impacts, or where there is sufficient uncertainty to warrant a rigorous numerical impact assessment. Air dispersion modelling must be conducted in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2005). http://www.environment.nsw.gov.au/resources/air/ammodelling05361.pdf.	A quantitative air quality assessment is prepared in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2022). See Section 6.
7. Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the Protection of the Environment Operations (POEO) Act (1997) and the POEO (Clean Air) Regulation (2010).	The object of the POEO Act is to achieve the protection, restoration and enhancement of the quality of the NSW environment. The activities listed in Schedule 1 to the POEO Act (broadly, activities with potentially significant environmental impacts) require an environmental protection licence (EPL). This Report seeks development approval for a modest sized quarry of extraction of up to 350,000 tpa.
8. Detail emission control techniques/practices that will be employed by the proposal. Consideration should be given to dust management techniques where water is unavailable or limited and the development of a Trigger Action Response Plan (TARP).	Proposed controls are described in Section 6.1.4 and Appendix A and the assessment of model predictions is undertaken against criteria specified in the Approved Methods (2022) in Section 4.

1. A 2022 update to the 'Approved Methods' was gazetted in 2022 and replaces the document dated August 2016

2 Project Description

2.1 Site Location

The proposed Gulgong Quarry is located in the mid-western region of the central west and Orana region of New South Wales. The subject quarry comprises part of Lot 1 in Deposited Plan (DP) 1239728 at No. 1848 Castlereagh Highway, Tallawang (Project Site), approximately 21.5km by road to the north of the township of Gulgong in the Mid-Western Regional Council area and 20.5 km south of the township of Dunedoo in Warrumbungle Shire. The project site is situated within the Mid-Western Regional Council area, and the location and approximate proposed quarry footprint are shown in Figure 2-1.

The quarry is accessed by the Castlereagh Highway, a state-controlled highway that runs north to south. From the project site location, the Castlereagh Highway runs north to State Route B84 and to Dunedoo, and south to Gulgong. The quarry access is directly off the Castlereagh Highway and includes approximately 500 meters of unsealed access. Quarry operations include unsealed haul route of approximately 600m, originating from the quarry to the Castlereagh Highway which is illustrated in Figure 2-2.

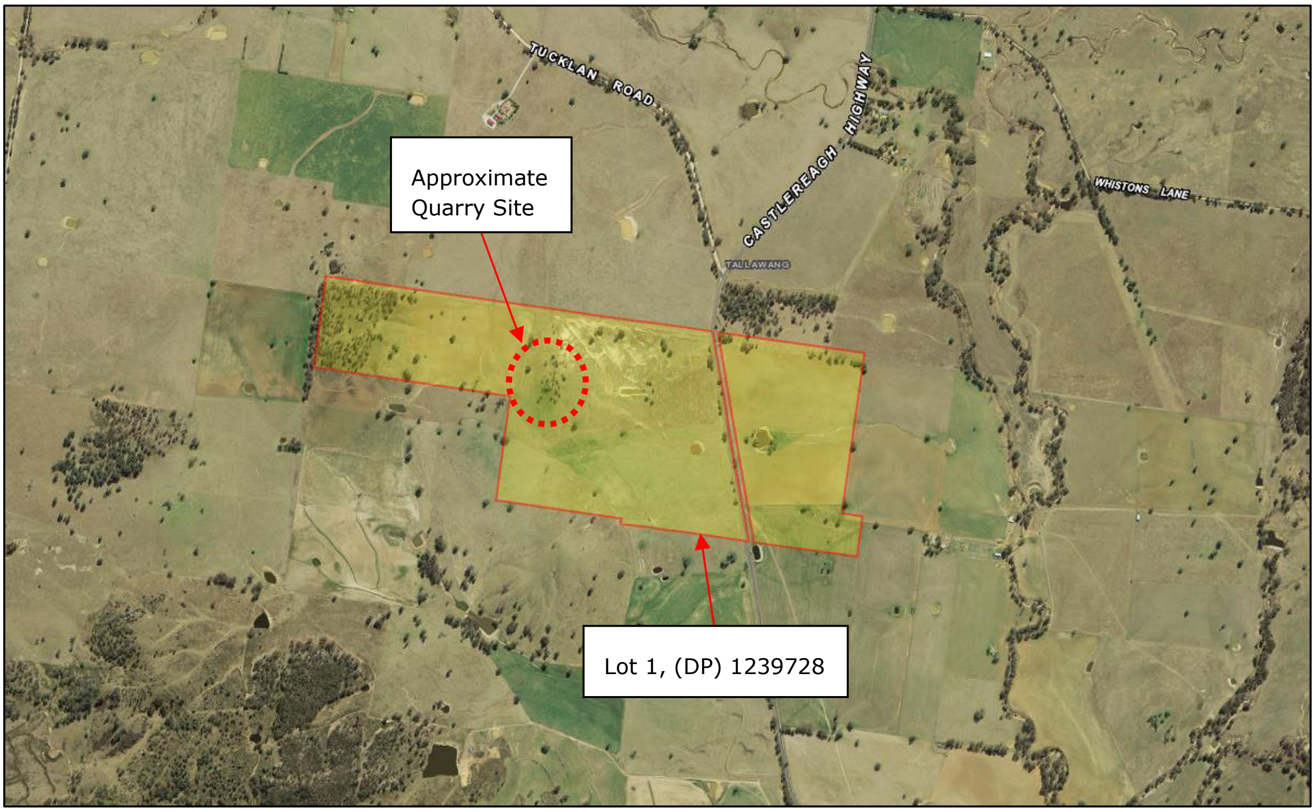


Figure 2-1: Project Site Location

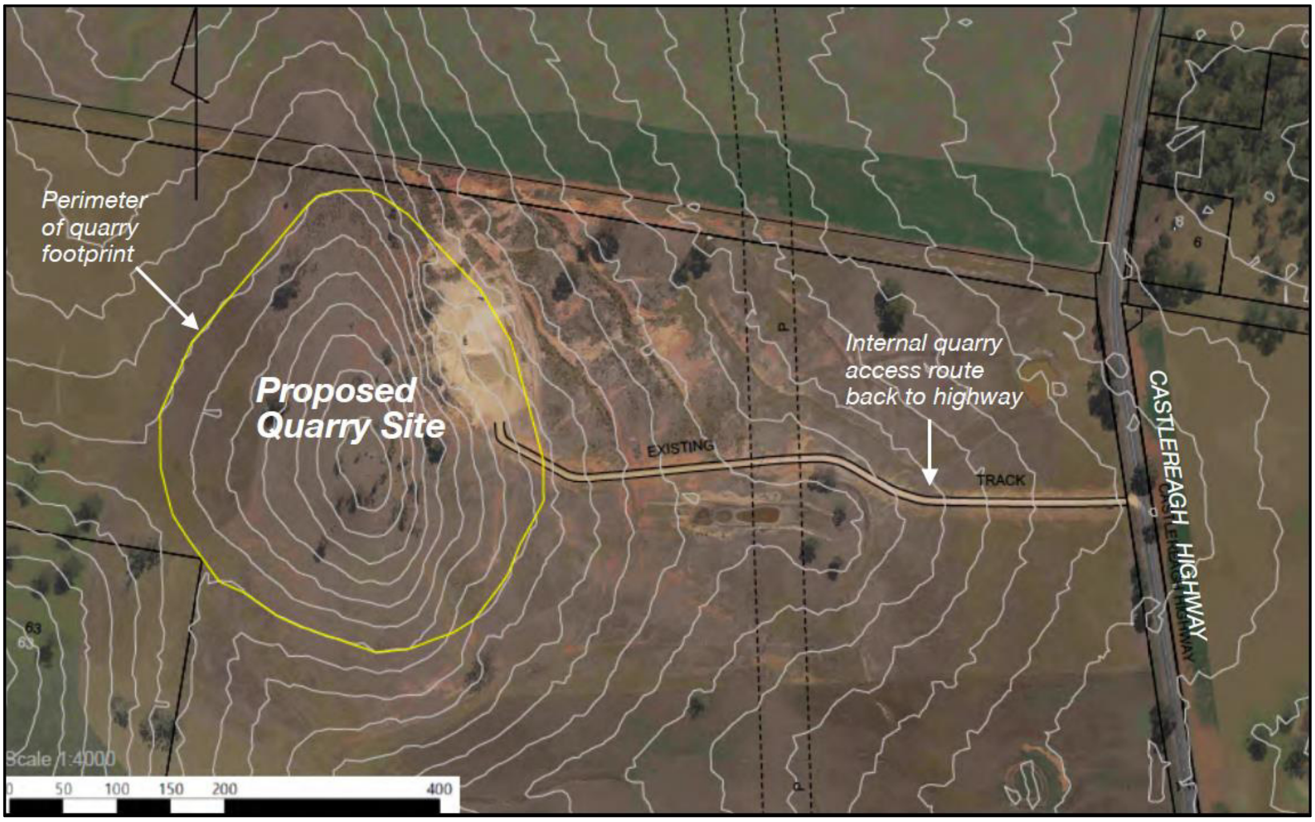


Figure 2-2: Haul Route

2.2 Air Sensitive Receivers

The region surrounding the project site is sparsely populated, with the air sensitive receptors (ASRs) in all directions and the closest approximately 950m north of the quarry as described in Table 2-1 and shown in Figure 2-3.

Table 2-1: List of Nearest Air Sensitive Receptors (ASRs)

Identifier	Lot Number	Address	Distance & Direction to Site
ASR 1	Lot 2 DP1239728	117 Tucklan Road Tallawang	950 N of Gulgong Quarry
ASR 2	Lot 98 DP750751	7 Corishs Lane Tallawang	1500m NW of Gulgong Quarry
ASR 3	Lot 73 DP750764	145 Spir Road Tallawang	3700 NW of Gulgong Quarry
ASR 4	Lot 11 DP253275	142b Suzanne Road Tallawang	3300m NW of Gulgong Quarry
ASR 5	Lot 12 DP253275	158 Suzanne Road Tallawang	3700m NW of Gulgong Quarry
ASR 6	Lot 15 DP253275	149 Suzanne Road Tallawang	4300m W of Gulgong Quarry
ASR 7	Lot 17 DP253275	111 Suzanne Road Tallawang	4000m W of Gulgong Quarry
ASR 8	Lot 18 DP253275	99 Suzanne Road Tallawang	4300m W of Gulgong Quarry
ASR 9	Lot 4 DP253275	42 Suzanne Road Tallawang	3000m W of Gulgong Quarry
ASR 10	Lot 1 DP253275	364 Corishs Lane Tallawang	3000m W of Gulgong Quarry
ASR 11	Lot 44 DP750751	353 Corishs Lane Tallawang	2700m W of Gulgong Quarry
ASR 12	Lot 77 DP750751	369 Montaza Road Tallawang	4700m SW of Gulgong Quarry
ASR 13	Lot 110 DP750751	83 Adelong Road Tallawang	4200m S of Gulgong Quarry
ASR 14	Lot 8 DP248183	50 Adelong Road Tallawang	4200m S of Gulgong Quarry
ASR 15	Lot 7 DP248183	40 Adelong Road Tallawang	4200m S of Gulgong Quarry
ASR 16	Lot 6 DP248183	76 Honeysett Road Tallawang	3300m S of Gulgong Quarry
ASR 17	Lot 1 DP248183	1637 Castlereagh Highway Tallawang	4100m SE of Gulgong Quarry
ASR 18	Lot 71 DP750751	1713 Castlereagh Highway Tallawang	3300m SE of Gulgong Quarry
ASR 19	Lot 171 DP750751	1848 Castlereagh Highway Tallawang	2200m SE of Gulgong Quarry
ASR 20	Lot 41 DP1248995	246 Whistons Lane Tallawang	3900 E of Gulgong Quarry
ASR 21	Lot 2 DP1106998	250 Whistons Lane Tallawang	4300 E of Gulgong Quarry
ASR 22	Lot 87 DP750767	330 Whistons Lane Tallawang	4500 NE of Gulgong Quarry
ASR 23	Lot 12 DP750751	2152 Castlereagh Highway Tallawang	4500 NE of Gulgong Quarry
ASR 24	Lot 18 DP750751	2162 Castlereagh Highway Tallawang	4550 NE of Gulgong Quarry

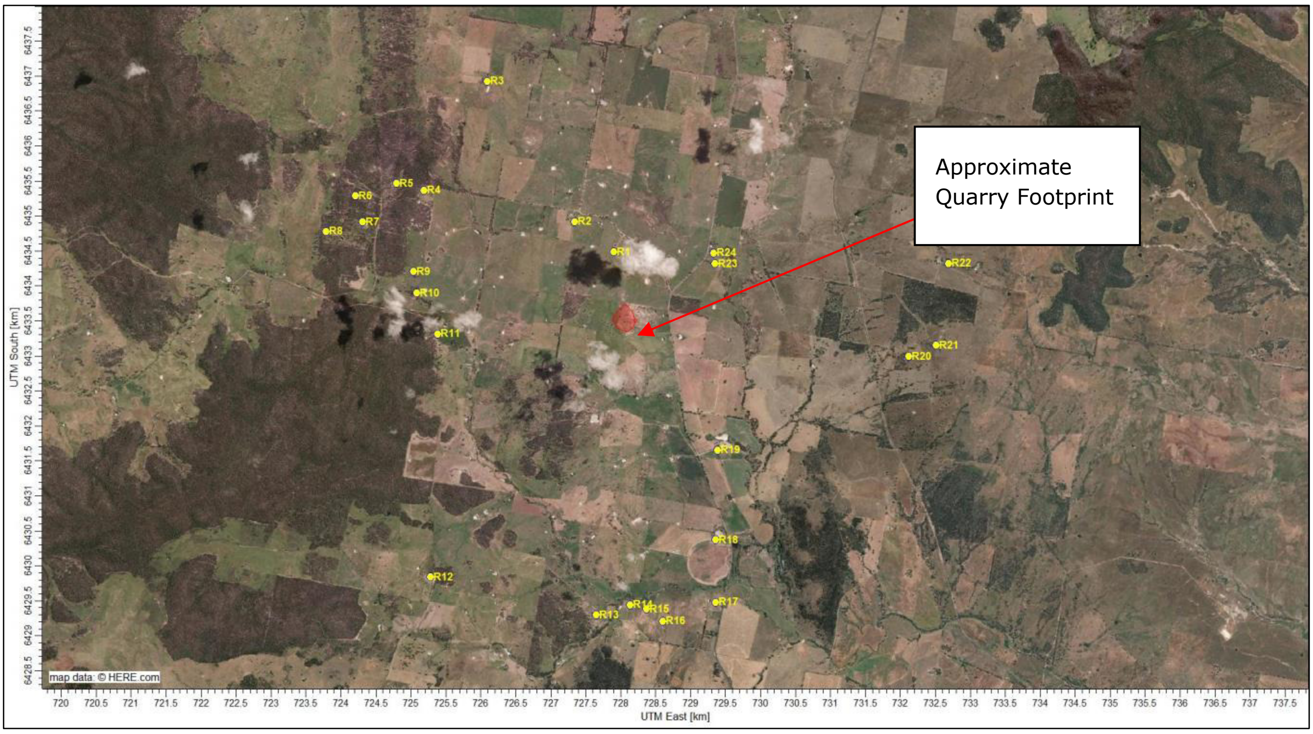


Figure 2-3: Sensitive Receptors Locations

2.3 Quarry Operations

It is intended that the extracted hard rock resources from the proposed Gulgong Quarry will principally serve the various state significant Central-west Orana Renewable Energy Zone (CWO-REZ) projects, including: EnergyCo's extensive, 1km wide CWO-REZ project located approximately 3.1km to the north, and Acciona's Orana Wind Farm project, located approximately 2km to the north.

The major features of the proposed Gulgong Quarry development may be summarised as follows:

- A total quarry resources estimated at 4.67 million tonnes (Mt).
- A maximum rate of extraction of 350,000 tonnes per annum.
- Establishment of a quarry footprint and progressive deepening of quarry
- The total quarry, including land proposed for lateral extension, will have an area of approximately 7.34ha.

The key project components relevant to the air quality assessment for the proposed Gulgong Quarry is summarised in Table 2-2.

Table 2-2: Key Quarry Project Components

Quarry Component	Summary Description
Extraction method	Bulldozer or excavator used to remove weathered rock, with drill and blast used for unweathered rock.
Quarry resource	Weathered and unweathered phyllite and meta-siltstone.
Disturbance area	Total quarry area approximately 7.34ha, with majority of existing internal access road back to the highway to be retained as is.
Processing	Crushing and screening of quarry resource on a campaign basis. Mobile plant and equipment to be brought to the site when required.
Annual extraction rate	Up to 350,000 tonnes per annum.
Transport	Access to the quarry from Castlereagh Highway from existing access point. A mix of truck and dog combination (33 tonnes +), with larger and smaller trucks used where road weight

	limits may apply. It is anticipated that the quarry will generate an average of 35 loaded trucks per day, generating up to 60 loaded quarry trucks per day.
Total recoverable resource and project life	Preliminary estimates indicate that the total quarry resource is estimated to be approximately 4.67 million tonnes (Mt). Quarry life is estimated to be 13-20 years (or more), dependent on the eventual rate of extraction and market demand for the resource.
Workforce	Up to 4 employees working on site + contractors (e.g. blasting contractor, machinery servicing contractors, refuelers).

The Project Site is not proposed to contain any habitable infrastructure, such as buildings and processing equipment such as crushers or screening equipment is proposed to be mobile. The only proposed fixed infrastructure on site is the internal access road to Castlereagh Highway.

The proposed hours of operation of Gulgong Quarry are outlined in Table 2-3.

Table 2-3: Current Operating Hours

Activity	Monday – Friday	Saturday	Sunday & Public Holidays
Extraction & Processing of the Resource	7:00am – 6:00pm	7:00am – 1:00pm	Not permitted
Blasting	9:00am – 3:00pm	Not permitted	Not permitted

2.3.1 Equipment

Quarry operations will utilise mobile machinery and equipment and is proposed to use the following equipment or similar equivalents:

- Jaw crusher with a scalping screen/radial stacker attached to jaw crusher. e.g. a Metso LT125 or Kleeman MC110
- A cone crusher with built in screens and conveyors. e.g. Metso 220D or Findlay 1540RS
- CAT D8 Dozer
- 38/50T Kobelco excavator
- CAT 740 Articulate Dump Truck
- CAT 972 Front End Loader
- Genset.

It is noted that air pollutants from diesel combustion may release other air pollutants such as particulate matter, (PM10 and PM2.5), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and trace quantities of volatile organic compounds. These substances are not considered to be emitted in sufficient quantities to affect air quality at sensitive receptors beyond the Project boundary; and have not been modelled in the air quality assessment.

3 Pollutants of Concern

The main emissions to air from quarrying operations are caused by wind-borne dust, vehicle usage, materials handling and transfers. Fugitive air emissions can be estimated using emission factors combined with site-specific information such as the silt and moisture content of material being handled.

Dust is a generic term used to describe fine particles that are suspended in the atmosphere. The dust emissions considered in this report are particulate matter in various sizes:

- Total Suspended Particles (TSP) - Particulate matter with a diameter up to 50 microns;
- PM_{10} - Particulate matter less than 10 microns in size;
- $PM_{2.5}$ - Particulate matter less than 2.5 microns in size; and
- Dust Deposition – deposited matter that falls out of the atmosphere.

4 Regulatory Framework

4.1 National Legislation

4.1.1 National Environment Protection Measure for Ambient Air Quality

Australia's first national ambient air quality standards were outlined in 1998 as part of the National Environment Protection Measure for Ambient Air Quality.

The Ambient Air Measure (referred to as Air NEPM) sets national standards for the key air pollutants; carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide, lead and particles (PM_{10}). A revision to the Measure was issued in 2021 with the inclusion of advisory $PM_{2.5}$ standards. The Air NEPM requires the State's governments to monitor air quality and to identify potential air quality problems.

4.2 State Legislation and Guidelines

4.2.1 Department of Environment and Conservations Approved Methods

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW Environment Protection Authority, 2022) detail both the assessment methodology and criteria for air quality assessments. Due to the type of industry and proximity to sensitive receptors, the requirements for a Level 2 assessment have been followed.

4.3 Project Criteria

The applicable criteria selected for this assessment are presented in Table 4-1.

Table 4-1: Project Air Quality Goals

Pollutant	Basis	Criteria	Averaging Time	Source
TSP	Human Health	90 $\mu g/m^3$	Annual	Approved Methods
PM_{10}	Human Health	50 $\mu g/m^3$	24-hour	Approved Methods
	Human Health	25 $\mu g/m^3$	Annual	Approved Methods
$PM_{2.5}$	Human Health	25 $\mu g/m^3$	24-hour	Approved Methods
	Human Health	8 $\mu g/m^3$	Annual	Approved Methods
Dust deposition	Amenity	Maximum incremental increase of 2 g/m^2/month	Annual	Approved Methods
	Amenity	Maximum total of 4 g/m^2/month	Annual	Approved Methods

5 Existing Environment

5.1 Terrain

The topography of land within the vicinity of the project site is variable, with ridge lines generally ranging between 400 metres (m) Australian Height Datum (AHD) and 500m AHD. The highest point is located south of the Goodiman State Conservation area at 600m AHD, and the lowest point at Tallaway Creek, to the east, at around 480m AHD or less.

Figure 5-1 shows the topography and the influences it has on the wind patterns in the surrounding environment. The wind fields are seen to follow the terrain well and indicate the simulation produces realistic fine scale flow fields (such as terrain forced flows) in surrounding areas.

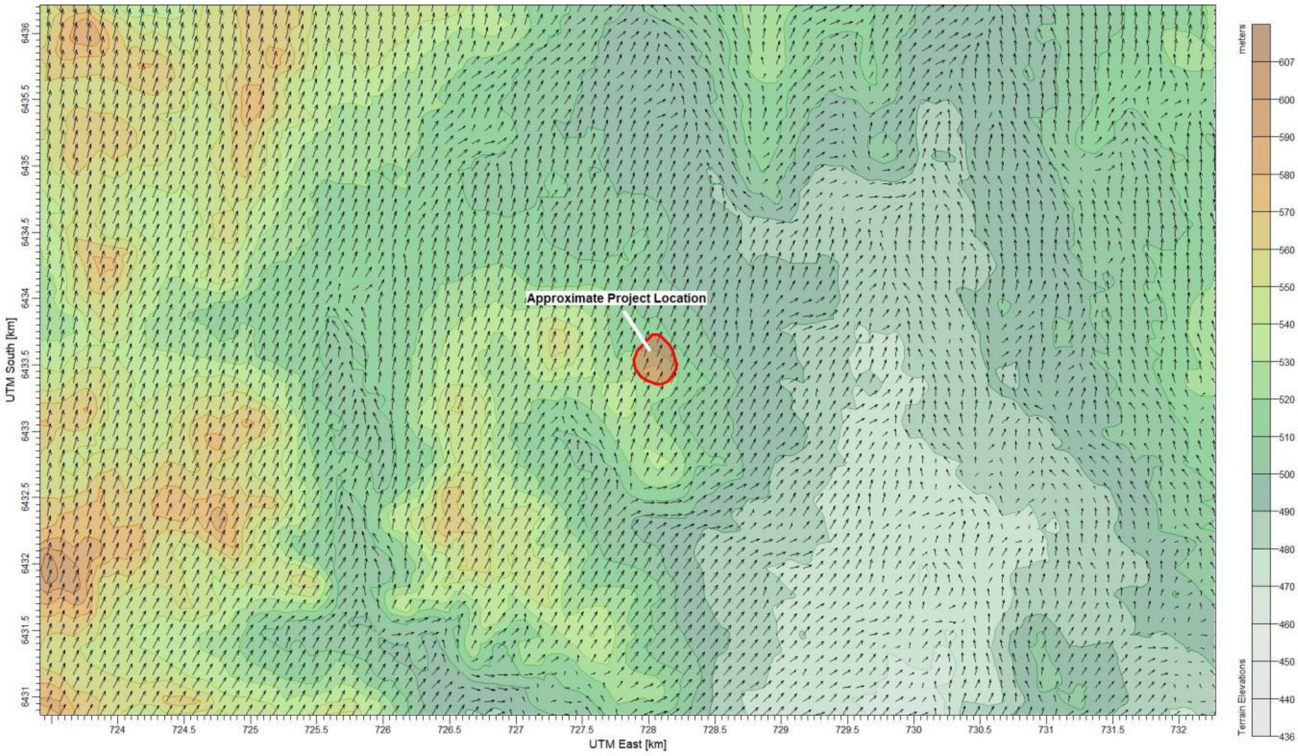


Figure 5-1: Terrain Wind Influences

5.2 Dispersion Meteorology

5.2.1 Regional Meteorology

The nearest open Bureau of Meteorology (BOM) station with long term data is at Gulgong (Site number 062013), located approximately 20 km south east of the Project site. This monitoring station has recorded data since 1881 and a summary of the long term climate is presented in Table 5-1.

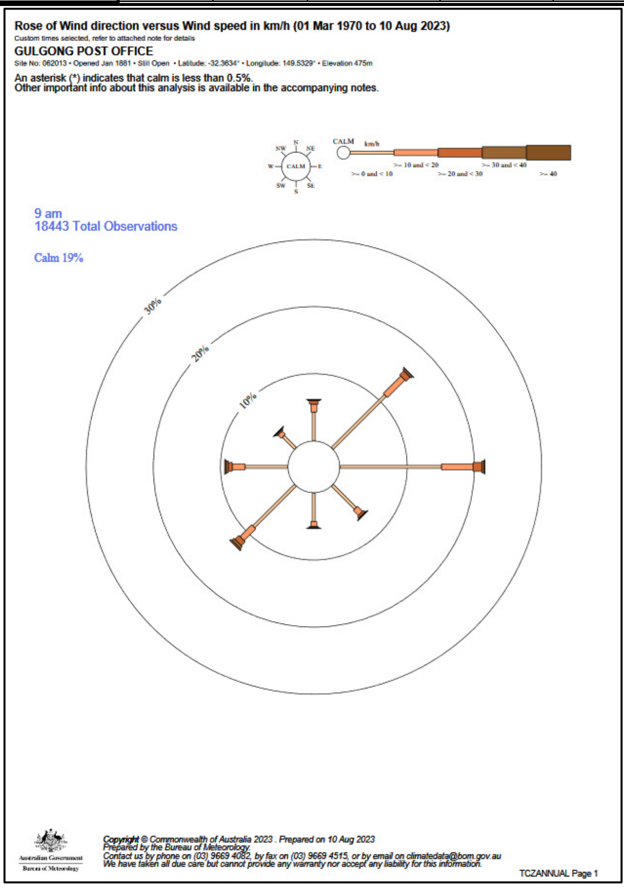
The long term mean temperature range is between 2.6°C and 31.2°C with the coldest month being July and the hottest months being December to February. On average, higher annual rainfall is received between December and February. Rainfall is lowest between April and September, with a mean annual rainfall of 653.2 mm. Rainfall reduces the dispersion of air emissions and therefore the potential impact on visual amenity and health.

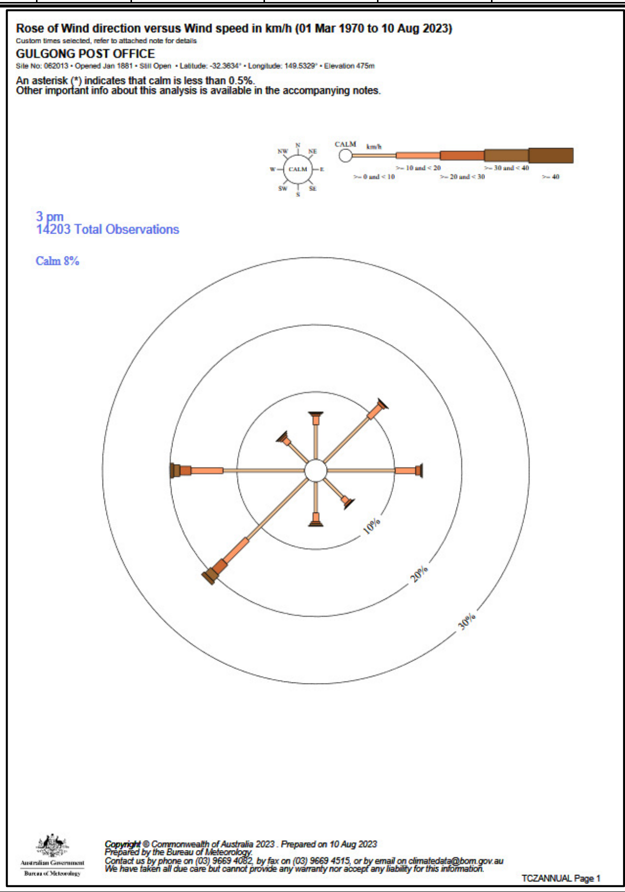
A review of the number of rainfall days per year at Gulgong shows that on average, the number of days where rainfall is ≥ 1 mm is 63 days per year.

The long term wind roses recorded daily at the Gulgong station at 9am and 3pm are provided in Figure 5-2. Winds are shown to be primarily from the east and northeast at 9am and experiences calms for 19% of the year. Winds are primarily from the west and southwest directions at 3pm and stronger winds (>40km/hr or >11.1m/s), with the potential to disturb dust in exposed areas, are rare.

Table 5-1: Long-term weather data for Gulgong [BOM]

Month	Mean Temperature		Rainfall		9 am Conditions			3 pm Conditions		
	Max (°C)	Min (°C)	Mean (mm)	Mean No. of Days ≥ 1 mm	Temp (°C)	RH (%)	Wind Speed (km/h)	Temp (°C)	RH (%)	Wind Speed (km/h)
Jan	31.2	16.9	70.2	5.3	21.7	64	8.2	29.5	37	9.6
Feb	30	16.4	62.2	4.8	20.6	71	6.7	28.4	42	8.5
Mar	27.5	13.8	56.9	4.6	18.9	71	6.2	26.2	41	7.9
Apr	23.5	9.9	44.2	3.9	15.8	70	5.9	22.3	42	7.8
May	19.1	6.3	44.3	4.7	11.3	79	5	18	49	9
Jun	15.5	3.7	50.3	6	7.7	84	4.4	14.3	57	8.8
Jul	14.8	2.6	49	6	6.7	84	4.9	13.5	54	9.9
Aug	16.5	3.4	45.6	5.7	8.5	76	6.1	15.3	46	11.7
Sep	19.8	6.1	46.9	5.2	12.6	70	7.7	18.5	44	11.4
Oct	23.7	9.3	55.6	5.6	16.5	61	9.1	22.1	40	11.5
Nov	26.8	12.3	60.9	5.6	18.3	63	9.1	25.1	39	11.4
Dec	29.8	15	66.9	5.5	20.8	62	8.9	28.2	36	11.2
Annual	**23.2**	**9.6**	**653.2**	**62.9**	**15**	**71**	**6.9**	**21.8**	**44**	**9.9**





Location: Gulgong BoM Station	Data Period: 1970 to 2023	Data Type: Measured Data

Figure 5-2: Annual wind roses for Gulgong Weather Station (1970 to 2023)

5.2.2 Local Meteorology

5.2.2.1 Introduction

A three dimensional meteorological field was required for the air dispersion modelling that includes a wind field generator accounting for slope flows, terrain effects and terrain blocking effects. The Air Pollution Model, or TAPM, is a three-dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research and can be used as a precursor to CALMET which produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables for each hour of the modelling period. The TAPM-CALMET derived dataset for 12 continuous months of hourly data from the year 2023 and approximately centred at the proposed Project has been used to provide further information on the local meteorological influences.

5.2.2.2 Wind Speed and Direction

The wind roses from the TAPM-CALMET derived dataset for the project site for the year 2023 are presented in Figure 5-3 and Figure 5-4. As shown in the figure, the annual wind patterns indicate that easterly winds are dominant during all seasons except winter. During the winter season, wind directions are variable, with winds from the northwest being dominant, along with prevalent westerly and easterly winds. Overall, winds from the south are infrequent which is likely indicative of the influences on wind flow from the elevated terrain in this direction.

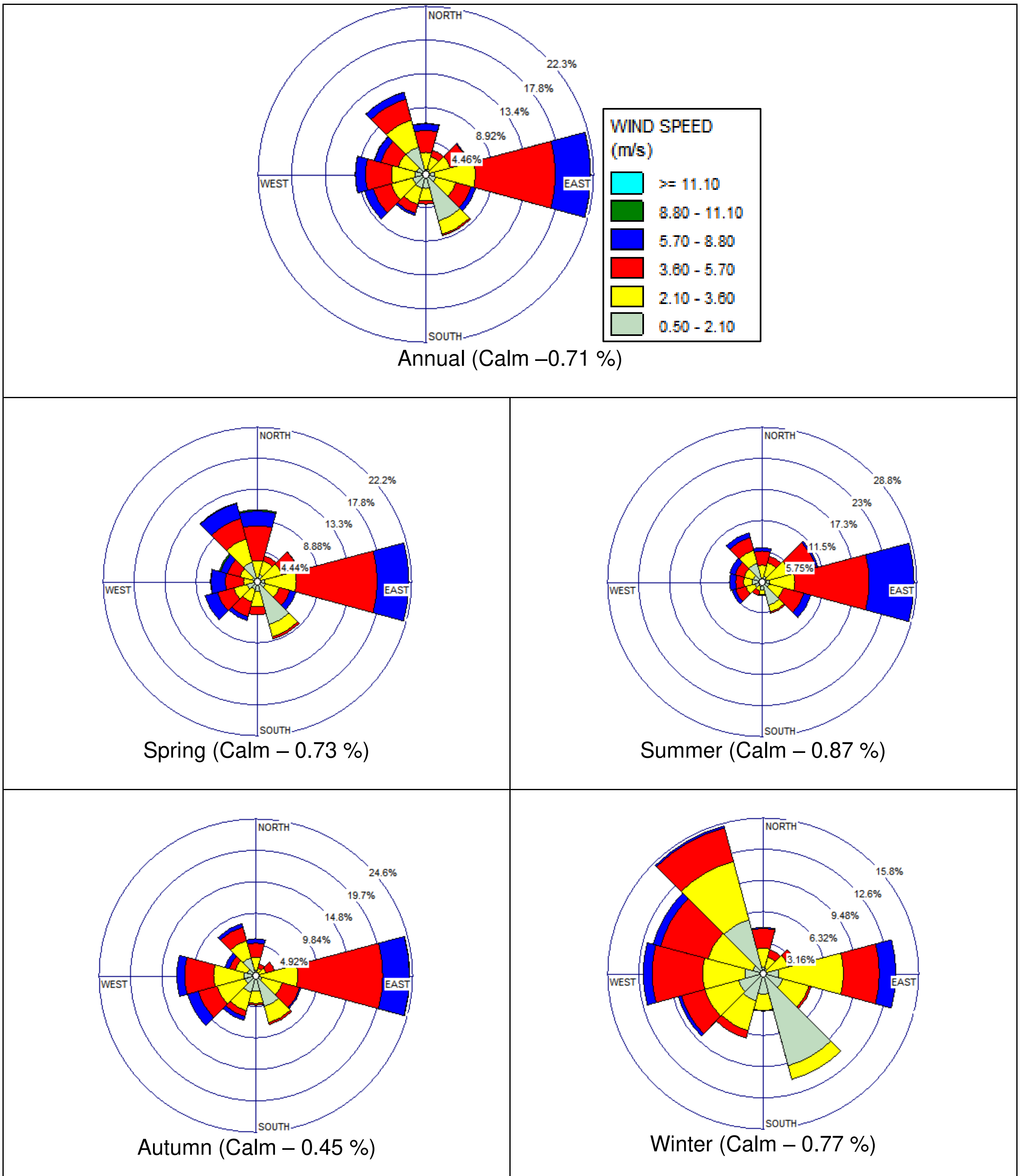


Figure 5-3: Site-specific wind roses by season for the TAPM-CALMET derived dataset, 2023

Figure 5-4 shows the wind roses for the time of day during the year for 2023 for the modelled data at a site as close as possible to the Gulgong BoM Station site. It can be seen that easterly winds are dominant at both times with some westerly and north westerly influences also apparent. These wind patterns are generally consistent with those shown for the long term measured data at the Gulgong BoM Station in Section 5.2.1.

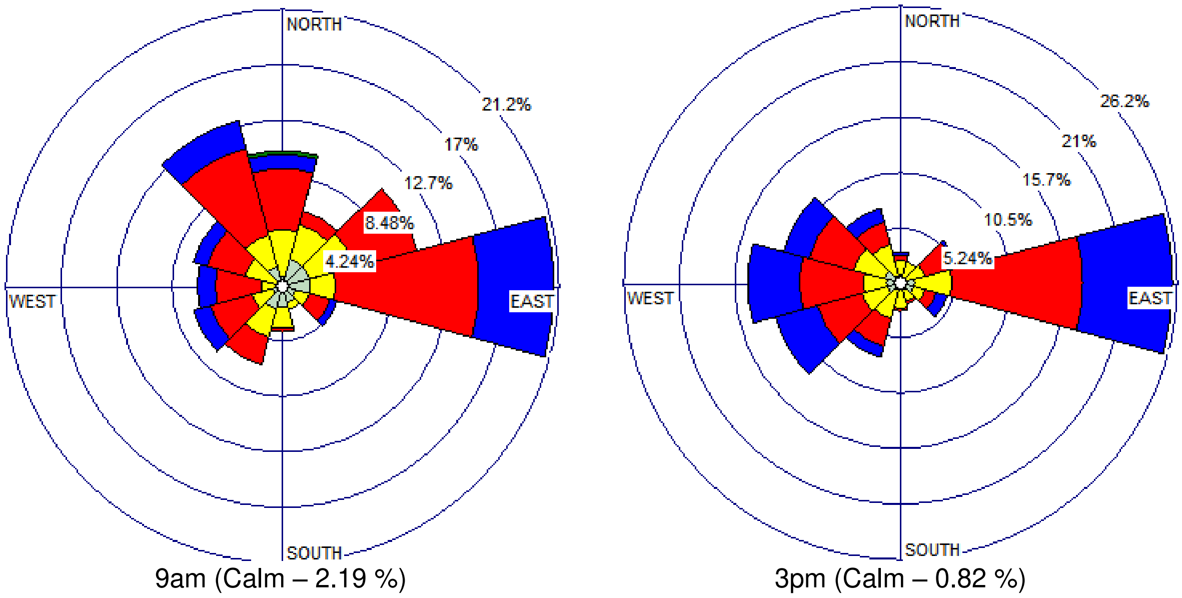


Figure 5-4: Gulgong site wind roses by time of day for the TAPM-CALMET derived dataset, 2023

5.2.2.3 Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion of pollutants. The Pasquill-Turner assignment scheme identifies six Stability Classes (Stability Classes A to F) to categorise the degree of atmospheric stability. These classes indicate the characteristics of the prevailing meteorological conditions and are used in various air dispersion models. The frequency of occurrence for each stability class for 2023 is shown in Figure 5-5. The data identifies that Stability Class D is most common; this stability class is indicative of neutral dispersion conditions.

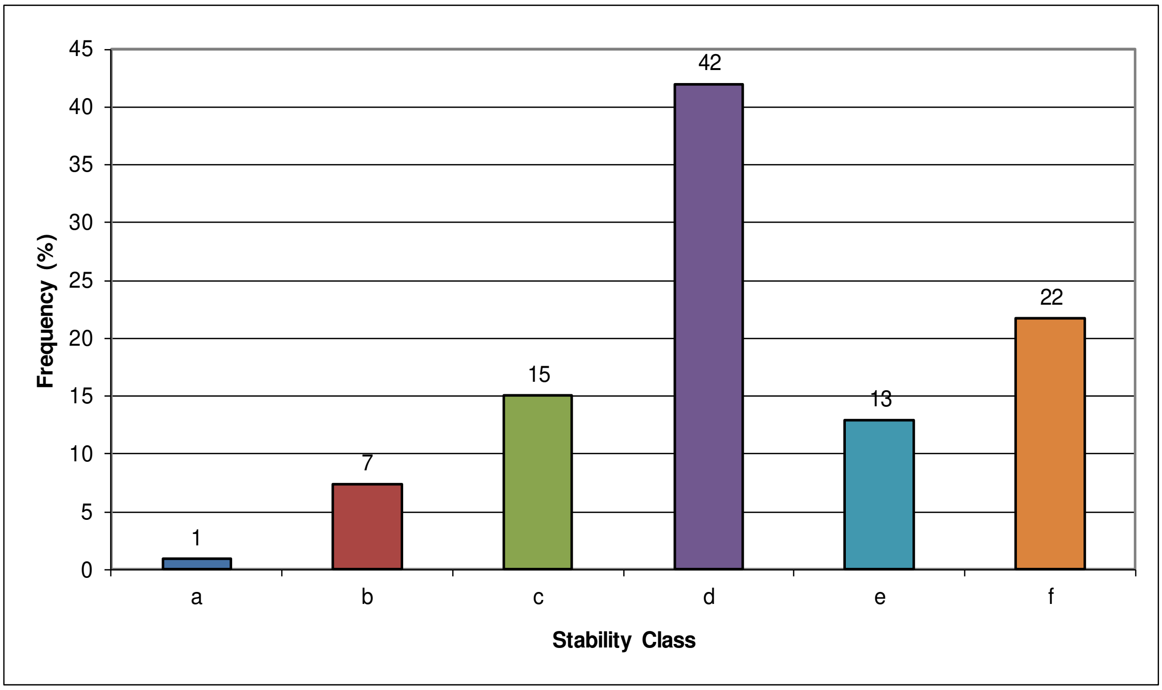


Figure 5-5: Stability class frequency for the TAPM-CALMET derived dataset, 2023

5.2.2.4 Mixing Height

Mixing height refers to the height above ground within which particulates or other pollutants released at or near ground can mix with ambient air. During stable atmospheric conditions, the mixing height is often quite low and particulate dispersion is limited to within this layer.

Diurnal variations in mixing depths are illustrated in Figure 5-6. As would be expected, an increase in the mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.

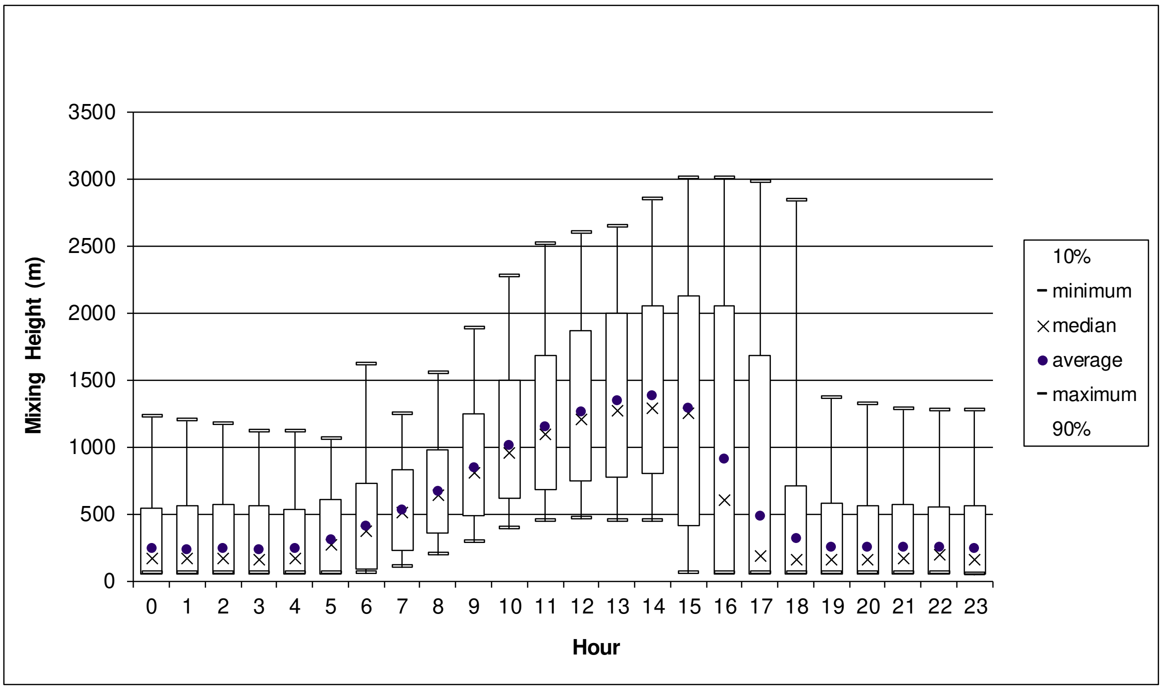


Figure 5-6: Mixing height for the TAPM-CALMET derived dataset, 2023

5.2.2.5 Temperature

Figure 5-7 shows the temperature profile of the TAPM-CALMET derived dataset. As shown in the figure, temperature predictions for the modelled data are lowest at 1.2^{0}C at night and early morning and highest at 37^{0}C in the afternoon, which is consistent with expectations for the region.

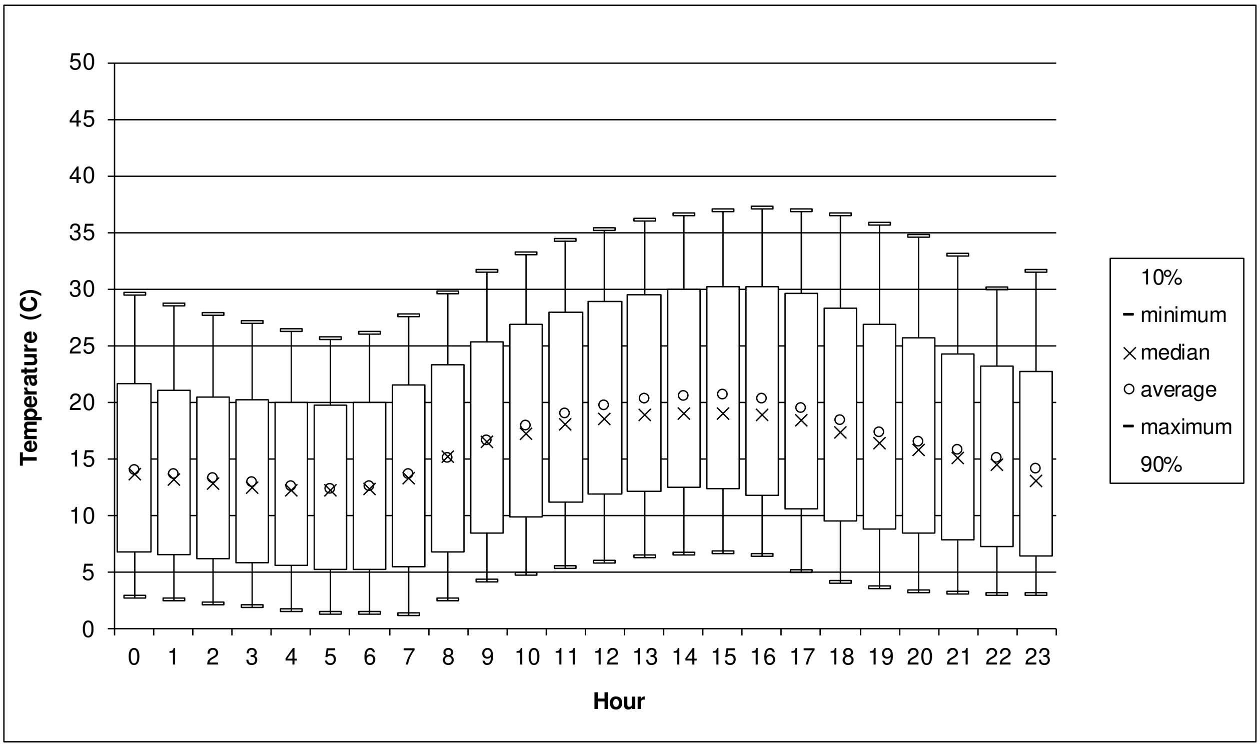


Figure 5-7: Temperature for the TAPM-CALMET derived dataset, 2023

5.3 Existing Air Quality

Gulgong Quarry is situated within a sparsely populated rural area. Background dust levels are therefore expected to be primarily impacted by agricultural activities.

An extensive network of NATA-accredited air quality monitoring stations which use Standards Australia methods, where available is operated by the NSW EPA. The closest monitoring site to the Project site is at Merriwa, approximately 99 km to the east and is considered to provide a generally representative background estimation of the remote rural concentration levels expected for the project site. Of the pollutants of interest, PM_{10} and $PM_{2.5}$ are measured at the Merriwa site. As with all NSW air quality monitoring stations concentration levels of these pollutants were elevated by smoke from bushfires in summer. Where available, the maximum 24 hour average data collected at this site for 2023 is outlined in Table 5-2 for a Level 1 Assessment as specified in the Approved Methods (2022). Individual 24-hour average predicted PM_{10} and $PM_{2.5}$ concentrations paired in time with the corresponding 24-hour concentration within the adopted 2023 monitoring dataset to obtain total impact at each receptor is provided for the Assessment. In addition, annual average concentration data are adopted for the background levels of pollutants requiring assessment for these periods (e.g. $PM_{2.5}$ and PM_{10}).

Where unavailable, a conservative assumption is adopted. For example, annual TSP background is derived as 2.5 x measured PM_{10} based on data collected around Australian mines (ACARP, 1999). No dust deposition data is available, however the results of dust deposition monitoring undertaken at similar locations in central Queensland have been utilised. The average dust deposition from monitoring at these locations is 33 mg/m^2/day. This is likely to be typical of annual average dust fallout in rural regions although higher levels may exist in the vicinity of local sources. Therefore, the average background deposition rate for the air quality impact assessment in relation to the Project has been assumed to be double the nominated monitoring result that is 2.0 g/m^2/month (67 mg/m^2/day). This methodology is consistent with the Approved Methods, which specifies criteria of 2 g/m^2/month without background and 4 g/m^2/month including background.

As shown in Table 5-2, the maximum measured 24 hour average $PM_{2.5}$ is already above the relevant criteria of 25 µg/m^3 and the maximum measured 24 hour average PM_{10} is very close to the criteria of 50 µg/m^3. Cumulative impacts are accounted for by adopting the background data which includes elevated concentrations of PM10 and PM2.5. These are therefore considered to be an overestimation of background pollutant concentrations at the project site. Nevertheless, they are included in the assessment in accordance with the requirements specified in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW.

Table 5-2: Assigned Background Concentrations

Parameter	Air Quality Criteria	Period	Maximum Measured	Adopted Background	Comments
TSP	90 µg/m^3	Annual	35.5 µg/m^3	35.5 µg/m^3	Conservative assumption
PM_{10}	50 µg/m^3	24 Hour	49.4 µg/m^3	Varies	NSW EPA Measurement
	25 µg/m^3	Annual	14.2 µg/m^3	14.2 µg/m^3	
$PM_{2.5}$	25 µg/m^3	24 Hour	27.1 µg/m^3	Varies	NSW EPA Measurement
	8 µg/m^3	Annual	4.7 µg/m^3	4.7 µg/m^3	
Dust Deposition	2 g/m^2/month	Month	-	-	-
	4 g/m^2/month	Month	2 g/m^2/month	2 g/m^2/month	Conservative assumption

6 Methodology

The air quality impact assessment has been carried out as follows:

- An emissions inventory of TSP, PM_{10}, $PM_{2.5}$, and deposited dust for the proposed Project was compiled using National Pollutant Inventory (NPI) and United States Environmental Protection Agency (USEPA) AP-42 emissions estimation methodology for the Project (outlined in Section 6.1).
- Estimated emissions data was used as input for air dispersion modelling. The modelling techniques were based on a combination of The Air Pollution Model (TAPM) prognostic meteorological model (developed by CSIRO), and the CALMET model suite used to generate a three-dimensional meteorological dataset for use in the CALPUFF dispersion model (Section 6.2).
- The atmospheric dispersion modelling results were assessed against the air quality assessment criteria described in Section 4.3 as part of the impact assessment (Section 7). Air quality controls are applied to reduce emission rates where applicable.

6.1 Estimated Emissions

6.1.1 Pollution Causing Activities

The air quality assessment takes into account dust generating activities from quarry activities and disturbed surfaces within the site boundaries. The main emissions to air are dust and particulate matter generated by the onsite activities which primarily occur as a result of the following activities:

- site clearance of areas including vegetation clearance, topsoil removal and storage, and earthworks
- excavation
- loading/unloading of haul trucks
- bulldozer and grader operations
- wind erosion from disturbed areas and stockpiles
- transfer points
- conveyors
- crushing and screening
- vehicle movements
- blasting and drilling

In addition, air pollutants from diesel combustion may release other air pollutants such as particulate matter, (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and trace quantities of volatile organic compounds. These substances are not considered to be emitted in sufficient quantities to affect air quality at sensitive receptors beyond the Project boundary; and have not been modelled in the air quality assessment.

6.1.2 Emission Estimation

Emission factors can be used to estimate emissions of TSP and PM_{10} to the air from various sources. Emission factors relate the quantity of a substance emitted from a source to some measure of activity associated with the source. Common measures of activity include distance travelled, quantity of material handled, or the duration of the activity.

Emission factors are used to estimate a facility's emissions by the general equation:

$$E_{i\,(kg/yr)} = \left[A_{(t/h)} \times OP_{(h/yr)} \right] \times EF_{i\,I(kg/t)} \times \left[1 - \frac{CE_i}{100} \right]$$

Where:

$E_{i\,(kg/yr)}$ = Emission rate of pollutant

$A_{(t/h)}$ = Activity rate

$OP_{(h/yr)}$ = operating hours

$EF_{i\,I(kg/t)}$ = uncontrolled emission factor of pollutant

CE_i = overall control efficiency for pollutant

The equations and activity rates are presented in Appendix A.

6.1.3 Emissions Scenarios Modelled

The operational scenario representing maximum activities has been modelled for this assessment.

6.1.4 Emission Controls

Emissions controls for dust abatement were included in the emissions estimation, summarised in Appendix A, Table A-1.

It should also be noted that some of the planned dust control measures are not easily quantifiable but will still serve to reduce dust emissions. The dispersion modelling study has taken a conservative approach and have not incorporated the effectiveness of these controls in the development of the emissions inventory.

- Routine visual monitoring and hazard minimisation.
- Planned activities will not occur during adverse weather conditions.
- All quarrying processing will be undertaken within a quarry pit, located below natural ground level.
- Stockpile limits to 6m in height.
- Drill Rig fitted with engineered dust extraction / suppression as appropriate.
- Progressively establish vegetation on any topsoil/overburden stockpiles and rehabilitated landforms and in buffers.
- Material drop-height will be minimised during stockpile building.
- The internal quarry haul route will be maintained in a good condition and will be sealed in part, nearest the highway intersection.

6.1.5 Emissions by Source

As discussed in Section 6.1, the emission estimation for individual activities accounting for control factors (outlined in Appendix A) has been derived from NPI Emission Estimation Technique manuals and US EPA AP42 documentation. The annual calculated emissions for TSP, PM_{10} and $PM_{2.5}$ are presented in for each source type. It is noted that the calculated emissions are conservatively estimated based upon proposed maximum daily activities allowing for 1,980 t/day.

Table 6-1: Calculated Annual Emissions by Source (kg/year)

Fugitive Source	TSP	PM_{10}	$PM_{2.5}$
Wind erosion (Pit & Stockpiles)	12,860	6,430	1,350
Wheel generated dust (Hauling internal and external)	23,568	6,965	401

Processing	18,720	7,488	412
Blasting/drilling (Pit)	6,218	3,248	450
Pit activities	35,321	11,324	3,709
total	**96,687**	**35,454**	**6,322**

6.2 Air Dispersion Modelling

6.2.1 TAPM

A 3-dimensional dispersion wind field model, CALPUFF, has been used to simulate the impacts from the Project. CALPUFF is an advanced non-steady-state meteorological and air quality modelling system developed and distributed by Earth Tech, Inc. The model has been approved for use in the '*Guideline on Air Quality Models*' (Barclay and Scire, 2011) as a preferred model for assessing applications involving complex meteorological conditions such as calm conditions.

To generate the broad scale meteorological inputs to run CALPUFF, this study has used the model The Air Pollution Model (TAPM), which is a 3-dimensional prognostic model developed and verified for air pollution studies by the CSIRO.

TAPM was configured as follows:-

- Centre coordinates – 32° 12.5 S, 149° 25.0 E;
- Dates modelled – 31st December 2022 to 31st December 2023 (1 start up day);
- Four nested grid domains of 30 km, 10 km, 3 km and 1 km;
- 30 x 30 grid points for all modelling domains;
- 25 vertical levels from 10 m to an altitude of 8000 m above sea level;
- Data assimilation using measured meteorological data from the NSW EPA Air Quality Monitoring Station at Merriwa; and
- The default TAPM databases for terrain, land use and meteorology were used in the model;

6.2.2 CALMET

CALMET is an advanced non-steady-state diagnostic three-dimensional meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system.

The CALMET simulation was run as No-Obs simulation with the gridded TAPM three-dimensional wind field data from the innermost grid. CALMET then adjusts the prognostic data for the kinematic effects of terrain, slope flows, blocking effects and three-dimensional divergence minimisation.

6.2.3 CALPUFF

CALPUFF is a non-steady-state Lagrangian Gaussian puff model. CALPUFF employs the three-dimensional meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal.

Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

Due to the limited change in topography as discussed in Section 2.6, the radius of influence of terrain features was set at 10 km while the minimum radius of influence was set as 0.1 km. The terrain data incorporated into the model had a resolution of 1 arc-second (approximately 30 m) in accordance with the *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'*.

6.2.4 Other Modelling Input Parameters

6.2.4.1 Particle Size Distribution

CALPUFF requires particle distribution data (geometric mass mean diameter, standard deviation) to compute the dispersion of particulates (*Table 6-2*).

Table 6-2: Particle Size Distribution Data

Particle size	Mean particle diameter (µm)	Geometric standard deviation (µm)
TSP	15	2
PM_{10}	4.88	1
$PM_{2.5}$	0.89	1

7 Assessment of Impacts

This section presents the results of the air quality impact assessment for predicted ground level concentrations of TSP, PM_{10} and $PM_{2.5}$ and dust deposition for the proposed operation of the Project.

The results of the dispersion modelling include individual sensitive receptor and contour plots that are indicative of ground-level concentrations and deposition. As outlined in the *'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'* a Level 1 impact assessment is presented for pollutants without elevated background (i.e. TSP, dust deposition and annual average PM10 and PM2.5) as follows:

- The incremental impact of each pollutant as per the criterion units and time periods; and
- The maximum background concentration) added to the 100th percentile model prediction.

A Level 2 impact assessment is presented for 24 hour average PM10 and PM2.5 which have elevated background concentrations close to or above the relevant ambient air quality criteria (see Section 5.3) and requires the predictions to be presented as follows:

- The results of the Level 1 impact assessment for these pollutants; and
- The sum for each individual dispersion model prediction with the corresponding measured background concentration (e.g. add the first hourly average dispersion model prediction to the first hourly average background concentration) to obtain hourly predictions of total impact.

7.1 TSP

The predicted Level 1 assessment annual average TSP is presented in Table 7-1.

The model predictions for TSP are well below the criteria of 90 µg/m^3. TSP emissions from the proposed Project are not predicted to adversely impact upon the sensitive receptors. A contour plot is presented in Appendix B.

Table 7-1: Predicted Annual Average TSP Concentrations (µg/m^3) – Level 1 Assessment

ID	Predicted Annual Average TSP Concentrations (µg/m^3)	
	Incremental	**Cumulative**
R1	0.34	35.84
R2	0.27	35.77
R3	0.23	35.73
R4	0.20	35.70
R5	0.13	35.63
R6	0.12	35.62
R7	0.09	35.59
R8	0.05	35.55

ID	Predicted Annual Average TSP Concentrations (µg/m³)	
	Incremental	Cumulative
R9	0.05	35.55
R10	0.04	35.54
R11	0.03	35.53
R12	0.03	35.53
R13	0.03	35.53
R14	0.03	35.53
R15	0.03	35.53
R16	0.03	35.53
R17	0.02	35.52
R18	0.02	35.52
R19	0.02	35.52
R20	0.02	35.52
R21	0.02	35.52
R22	0.02	35.52
R23	0.01	35.51
R24	0.01	35.51
Criteria	**90**	

7.2 PM_{10}

The Level 1 assessment maximum predicted 24 hour (including maximum measured background of 49.4 µg/m³) and annual average (including measured annual background of 14.2 µg/m³) PM_{10} are presented in Table 7-2.

As shown in Table 7-2, the model predictions for annual average PM_{10} are below the criteria of 25 µg/m³. The model predictions for cumulative 24 hour average PM_{10} are above the criteria of 50 µg/m³. As noted in Section 5.2.1, the measured 24 hour background PM_{10} of 49.4 µg/m³ is already almost at the criteria of 50 µg/m³. The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* provides the following guidance when dealing with elevated background:

In some locations, existing ambient air pollutant concentrations may exceed the impact assessment criteria from time to time. In such circumstances, a licensee must demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical.

A worked example involving elevated background is also provided in the Approved Methods in which a modelling assessment is refined by adding each individual dispersion model prediction to the corresponding measured background concentration (i.e. a Level 2 assessment). Further investigation of the contemporaneous measured background and predicted data is therefore undertaken here in accordance with the worked example.

Table 7-3 provides the Level 2 assessment maximum cumulative concentrations at each receptor including contemporaneous background concentrations and associated number of exceedances of the criteria for the modelled year and Figure 7-1 and Figure 7-2 show the time series data for incremental and cumulative results for the two highest effected receptors.

As shown in Table 7-3 and Figure 7-1 and Figure 7-2, no exceedances of the 24 hour average PM_{10} criteria (50 µg/m³) are predicted at each of the receptors modelled. Furthermore, the greatest contribution of the quarry emissions to the cumulative PM_{10} is relatively low (maximum of 20.4 µg/m³) compared with the background and does not contribute to any exceedances of the relevant criteria. As specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, under these circumstances no additional assessment is therefore required.

The 24 hour and annual average PM_{10} emissions from the proposed Project are not predicted to adversely impact upon the sensitive receptors. Contour plots are provided in Appendix B***.***

Table 7-2: Predicted 24 Hour and Annual Average PM_{10} Concentrations (µg/m³) - Level 1 assessment

ID	Predicted 24 Hour Average PM_{10} Concentrations (µg/m³)		Predicted Annual Average PM_{10} Concentrations (µg/m³)	
	Incremental	Cumulative	Incremental	Cumulative
R1	20.04	69.44	0.45	14.65
R2	6.07	55.47	0.24	14.44
R3	1.04	50.44	0.03	14.23
R4	1.98	51.38	0.06	14.26
R5	2.31	51.71	0.05	14.25
R6	1.96	51.36	0.05	14.25
R7	2.19	51.59	0.07	14.27
R8	1.90	51.30	0.07	14.27
R9	3.42	52.82	0.20	14.40
R10	4.50	53.90	0.29	14.49
R11	4.46	53.86	0.39	14.59
R12	0.91	50.31	0.03	14.23
R13	1.20	50.60	0.04	14.24
R14	2.09	51.49	0.06	14.26
R15	2.34	51.74	0.07	14.27
R16	1.67	51.07	0.07	14.27
R17	0.92	50.32	0.05	14.25
R18	1.47	50.87	0.08	14.28
R19	5.96	55.36	0.21	14.41
R20	2.10	51.50	0.06	14.26
R21	1.32	50.72	0.05	14.25
R22	1.58	50.98	0.06	14.26
R23	11.37	60.77	0.35	14.55
R24	6.55	55.95	0.28	14.48
Criteria	**50**		**25**	

Table 7-3: Predicted Cumulative 24 Hour Average PM_{10} Concentrations and Number of Exceedances (µg/m³)[a] - Level 2 assessment

ID	Predicted Cumulative 24 Hour Average PM_{10} Concentrations (µg/m³)	Number of Exceedances
R1	49.44	0
R2	49.44	0
R3	49.44	0
R4	49.44	0
R5	49.44	0
R6	49.44	0
R7	49.44	0
R8	49.44	0
R9	49.44	0
R10	49.44	0
R11	49.44	0
R12	49.44	0

ID	Predicted Cumulative 24 Hour Average PM_{10} Concentrations ($\mu g/m^3$)	Number of Exceedances
R13	49.44	0
R14	49.45	0
R15	49.49	0
R16	49.51	0
R17	49.47	0
R18	49.67	0
R19	49.57	0
R20	49.44	0
R21	49.44	0
R22	49.44	0
R23	49.44	0
R24	49.44	0
Criteria	**50**	

a Note – There are no exceedances of criteria by measured background data

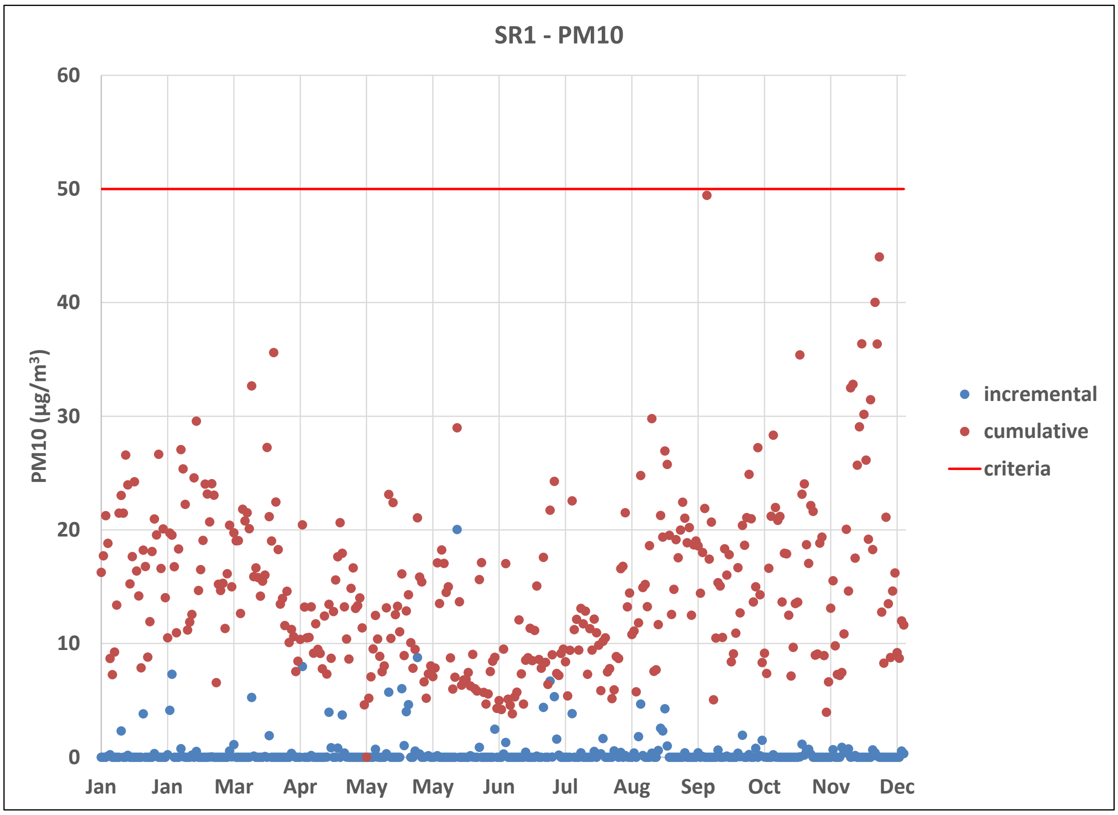


Figure 7-1: Timeseries of 24 hour predicted PM_{10} concentrations in isolation and cumulative at SR1

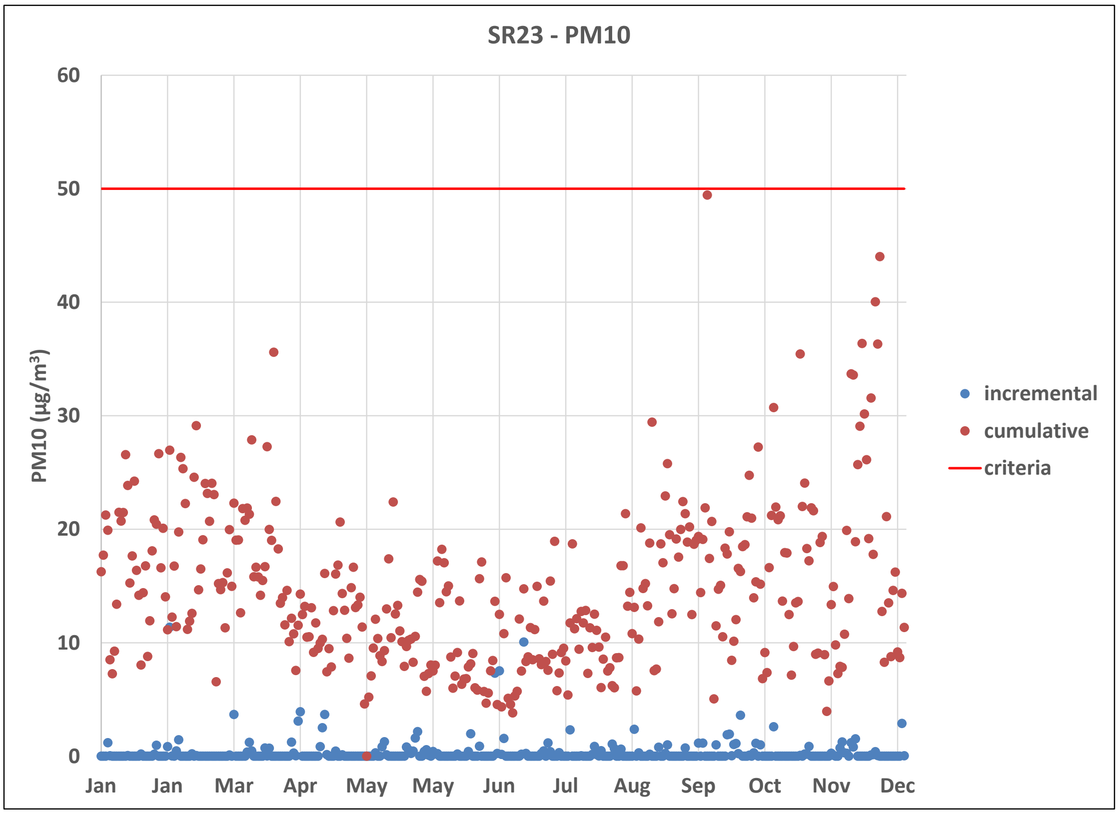


Figure 7-2: Timeseries of 24 hour predicted PM_{10} concentrations in isolation and cumulative at SR23

7.3 $PM_{2.5}$

The Level 1 assessment maximum predicted 24 hour (including maximum measured background of 27.1 µg/m³) and annual average (including measured annual background of 4.2 µg/m3) $PM_{2.5}$ are presented in Table 7-4.

The model predictions for annual average $PM_{2.5}$ are below the criteria of 8 µg/m3. As shown in Table 7-4, the cumulative model predictions for 24 hour average $PM_{2.5}$ are above the 25 µg/m³ criteria, however, the measured 24 hour background $PM_{2.5}$ of 27.1 µg/m³ is already above the criteria of 25 µg/m³. The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* provides the following guidance when dealing with elevated background:

In some locations, existing ambient air pollutant concentrations may exceed the impact assessment criteria from time to time. In such circumstances, a licensee must demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical.

A worked example involving elevated background is also provided in the Approved Methods in which a modelling assessment is refined by adding each individual dispersion model prediction to the corresponding measured background concentration (i.e. a Level 2 assessment). Further investigation of the contemporaneous measured background and predicted data is therefore undertaken here in accordance with the worked example.

Table 7-5 provides the Level 2 assessment maximum cumulative concentrations at each receptor including contemporaneous background concentrations and associated number of exceedances of the criteria for the modelled year and Figure 7-3 and Figure 7-4 show the time series data for incremental and cumulative results for the two highest effected receptors.

As shown in Figure 7-3 and Figure 7-4, 1 exceedance of the 24 hour average $PM_{2.5}$ criteria (25 µg/m³) are predicted at each of the receptors modelled. These exceedances correspond to the date of elevated measured background which also exceed the criteria. Furthermore, the greatest contribution of the quarry emissions to the cumulative $PM_{2.5}$ is relatively low (maximum of 0.09 µg/m³) compared with the background and does not contribute to any additional exceedances of the relevant criteria. As specified in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, under these circumstances no additional assessment is therefore required.

The 24 hour and annual average $PM_{2.5}$ emissions from the proposed Project are not predicted to adversely impact upon the sensitive receptors. Contour plots are provided in Appendix B.

Table 7-4: Predicted 24 Hour and Annual Average $PM_{2.5}$ Concentrations ($\mu g/m^3$) - Level 1 assessment

ID	Predicted 24 Hour Average $PM_{2.5}$ Concentrations ($\mu g/m^3$)		Predicted Annual Average $PM_{2.5}$ Concentrations ($\mu g/m^3$)	
	Incremental	Cumulative	Incremental	Cumulative
R1	4.41	31.51	0.09	4.79
R2	1.35	28.45	0.05	4.75
R3	0.22	27.32	0.01	4.71
R4	0.39	27.49	0.01	4.71
R5	0.47	27.57	0.01	4.71
R6	0.40	27.50	0.01	4.71
R7	0.45	27.55	0.02	4.72
R8	0.39	27.49	0.02	4.72
R9	0.70	27.80	0.05	4.75
R10	0.96	28.06	0.07	4.77
R11	0.96	28.06	0.09	4.79
R12	0.19	27.29	0.01	4.71
R13	0.25	27.35	0.01	4.71
R14	0.43	27.53	0.01	4.71
R15	0.47	27.57	0.01	4.71
R16	0.32	27.42	0.02	4.72
R17	0.21	27.31	0.01	4.71
R18	0.30	27.40	0.02	4.72
R19	1.29	28.39	0.04	4.74
R20	0.42	27.52	0.01	4.71
R21	0.27	27.37	0.01	4.71
R22	0.33	27.43	0.01	4.71
R23	2.36	29.46	0.07	4.77
R24	1.47	28.57	0.06	4.76
Criteria	**25**		**8**	

Table 7-5: Predicted Cumulative 24 Hour Average $PM_{2.5}$ Concentrations and Number of Exceedances ($\mu g/m^3$)[a] - Level 2 assessment

ID	Predicted Cumulative 24 Hour Average $PM_{2.5}$ Concentrations ($\mu g/m^3$)	Number of Exceedances
R1	27.06	1
R2	27.06	1
R3	27.06	1
R4	27.06	1
R5	27.06	1
R6	27.06	1
R7	27.07	1
R8	27.07	1
R9	27.09	1
R10	27.08	1

ID	Predicted Cumulative 24 Hour Average $PM_{2.5}$ Concentrations ($\mu g/m^3$)	Number of Exceedances
R11	27.19	1
R12	27.07	1
R13	27.07	1
R14	27.07	1
R15	27.07	1
R16	27.07	1
R17	27.07	1
R18	27.07	1
R19	27.10	1
R20	27.06	1
R21	27.06	1
R22	27.06	1
R23	27.06	1
R24	27.06	1
Criteria	**25**	

a Note - number of exceedances of criteria by measured background data is 1

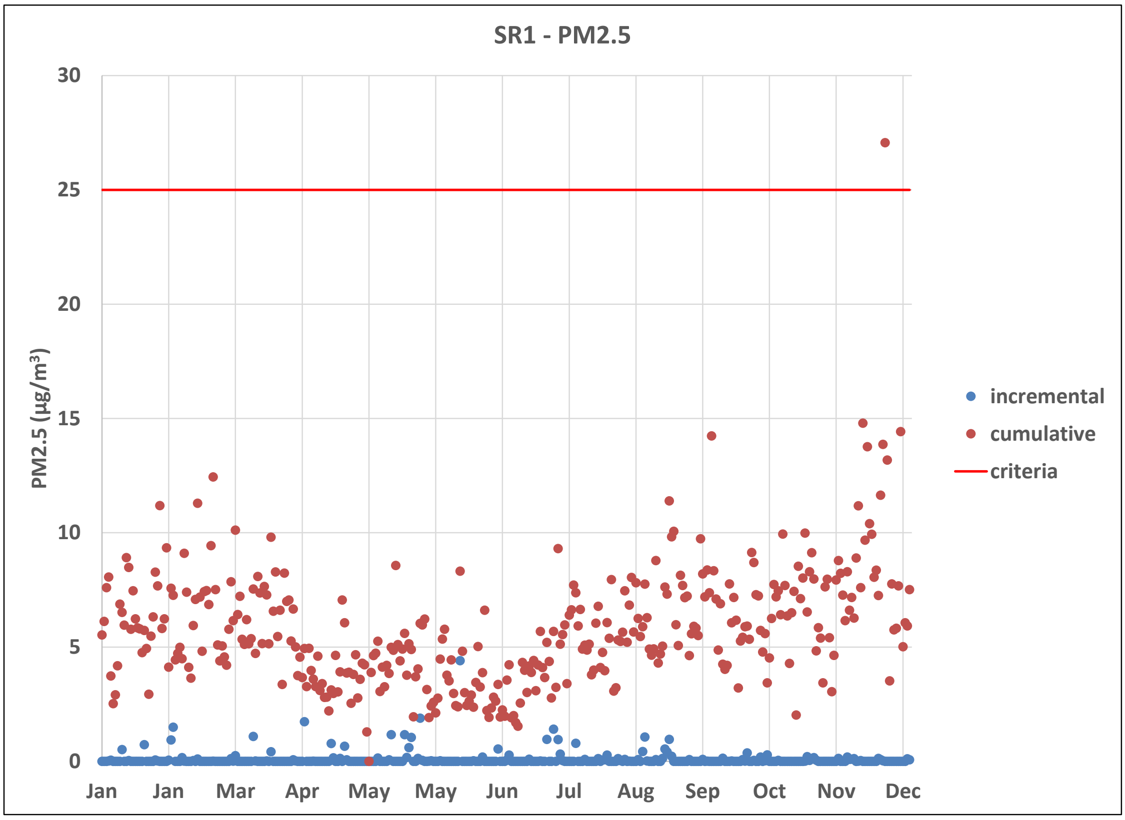


Figure 7-3: Timeseries of 24 hour predicted $PM_{2.5}$ concentrations in isolation and cumulative at SR1

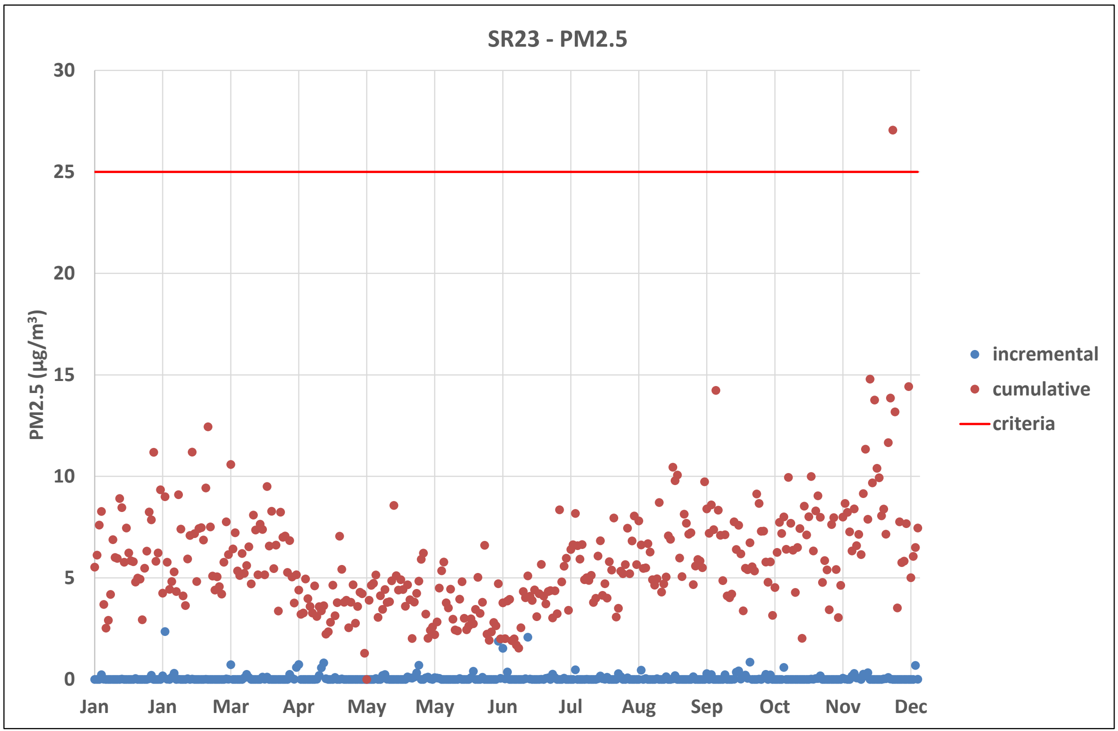


Figure 7-4: Timeseries of 24 hour predicted $PM_{2.5}$ concentrations in isolation and cumulative at SR23

7.4 Dust Deposition

The Level 1 assessment maximum predicted monthly average dust deposition are presented in Table 7-6.

The model predictions for incremental and cumulative monthly average dust deposition are well below the criteria of 2 g/m²/month and 4 g/m²/month. Dust deposition from the proposed Project is not predicted to adversely impact upon the sensitive receptors. Contour plots are provided in Appendix B.

Table 7-6: Predicted Monthly Average Dust Deposition (g/m²/month) - Level 1 assessment

ID	Predicted Monthly Average Dust Deposition (g/m²/month)	
	Incremental	**Cumulative**
R1	0.074	2.07
R2	0.033	2.03
R3	0.005	2.00
R4	0.012	2.01
R5	0.011	2.01
R6	0.009	2.01
R7	0.013	2.01
R8	0.013	2.01
R9	0.026	2.03
R10	0.053	2.05
R11	0.082	2.08
R12	0.002	2.00
R13	0.004	2.00
R14	0.007	2.01
R15	0.006	2.01
R16	0.009	2.01

ID	Predicted Monthly Average Dust Deposition (g/m²/month)	
	Incremental	Cumulative
R17	0.010	2.01
R18	0.015	2.01
R19	0.034	2.03
R20	0.017	2.02
R21	0.013	2.01
R22	0.012	2.01
R23	0.052	2.05
R24	0.047	2.05
Criteria	**2**	**4**

8 Conclusion

An Air Quality Impact Assessment has been carried out in support of a development consent application for a quarry at Tallawang NSW, otherwise known as 'Gulgong Quarry'. The Proponent proposes development of the hard rock quarry with quarry footprint totalling approximately 7.34ha, a total resource of approximately 4.6 million tonnes and a proposed extraction rate of up to 350,000 tonnes per annum. It is anticipated that the quarry will generate an average of 35 loaded trucks per day, generating up to 60 loaded quarry trucks per day

As summarised in Table 8-1 and Table 8-2, the results of the modelling have shown that the TSP, PM_{10}, $PM_{2.5}$ and dust deposition predictions comply with the relevant criteria and averaging periods at all sensitive receptors modelled for the Project in isolation.

TSP, dust deposition and annual average PM_{10} and $PM_{2.5}$ predictions are also less than criteria for the Project including background at all sensitive receptors modelled. Whilst the 24 hour average PM_{10} and $PM_{2.5}$ predictions are above, The exceedances are driven by the elevated background adopted for the assessment, which are already above or close to the criteria. No additional exceedances of the criteria at these receptors are predicted to occur as a result of the proposed quarry operations and that best management practices will be implemented to minimise emissions as far as is practical. In the absence of the elevated background therefore, we would anticipate no exceedances of the criteria. As specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, under these circumstances no additional assessment is therefore required at these receptors.

It is therefore concluded that air quality should not be a constraint for the proposed quarry.

Table 8-1: Summary of Results – Project in Isolation

ID	Predicted Concentrations (µg/m³)					Dust deposition (g/m²/month)	Compliant
	PM10		PM2.5		TSP		
	24 h	Annual	24 h	Annual	Annual	Month	
SR1	20.04	0.45	4.41	0.09	0.34	0.074	✓
SR2	6.07	0.24	1.35	0.05	0.27	0.033	✓
SR3	1.04	0.03	0.22	0.01	0.23	0.005	✓
SR4	1.98	0.06	0.39	0.01	0.2	0.012	✓
SR5	2.31	0.05	0.47	0.01	0.13	0.011	✓
SR6	1.96	0.05	0.4	0.01	0.12	0.009	✓
SR7	2.19	0.07	0.45	0.02	0.09	0.013	✓
SR8	1.9	0.07	0.39	0.02	0.05	0.013	✓
SR9	3.42	0.2	0.7	0.05	0.05	0.026	✓
SR10	4.5	0.29	0.96	0.07	0.04	0.053	✓

ID	Predicted Concentrations (µg/m³)					Dust deposition (g/m²/month)	Compliant
	PM_{10}		$PM_{2.5}$		TSP		
	24 h	Annual	24 h	Annual	Annual	Month	
SR11	4.46	0.39	0.96	0.09	0.03	0.082	✓
SR12	0.91	0.03	0.19	0.01	0.03	0.002	✓
SR13	1.2	0.04	0.25	0.01	0.03	0.004	✓
SR14	2.09	0.06	0.43	0.01	0.03	0.007	✓
SR15	2.34	0.07	0.47	0.01	0.03	0.006	✓
SR16	1.67	0.07	0.32	0.02	0.03	0.009	✓
SR17	0.92	0.05	0.21	0.01	0.02	0.010	✓
SR18	1.47	0.08	0.3	0.02	0.02	0.015	✓
SR19	5.96	0.21	1.29	0.04	0.02	0.034	✓
SR20	2.1	0.06	0.42	0.01	0.02	0.017	✓
SR21	1.32	0.05	0.27	0.01	0.02	0.013	✓
SR22	1.58	0.06	0.33	0.01	0.02	0.012	✓
SR23	11.37	0.35	2.36	0.07	0.01	0.052	✓
SR24	6.55	0.28	1.47	0.06	0.01	0.047	✓
Criteria	**50**	**25**	**25**	**8**	**90**	**2**	

Table 8-2: Summary of Results – Cumulative

ID	Predicted Concentrations (µg/m³)					Dust deposition (g/m²/month)	Compliant
	PM_{10}		$PM_{2.5}$		TSP		
	24 h	Annual	24 h	Annual	Annual	Month	
SR1	69.44	14.65	31.51	4.79	35.84	2.07	✓
SR2	55.47	14.44	28.45	4.75	35.77	2.03	✓
SR3	50.44	14.23	27.32	4.71	35.73	2.00	✓
SR4	51.38	14.26	27.49	4.71	35.7	2.01	✓
SR5	51.71	14.25	27.57	4.71	35.63	2.01	✓
SR6	51.36	14.25	27.5	4.71	35.62	2.01	✓
SR7	51.59	14.27	27.55	4.72	35.59	2.01	✓
SR8	51.3	14.27	27.49	4.72	35.55	2.01	✓
SR9	52.82	14.4	27.8	4.75	35.55	2.03	✓
SR10	53.9	14.49	28.06	4.77	35.54	2.05	✓
SR11	53.86	14.59	28.06	4.79	35.53	2.08	✓

ID	Predicted Concentrations (µg/m³)					Dust deposition (g/m²/month)	Compliant
	PM_{10}		$PM_{2.5}$		TSP		
	24 h	Annual	24 h	Annual	Annual	Month	
SR12	50.31	14.23	27.29	4.71	35.53	2.00	✓
SR13	50.6	14.24	27.35	4.71	35.53	2.00	✓
SR14	51.49	14.26	27.53	4.71	35.53	2.01	✓
SR15	51.74	14.27	27.57	4.71	35.53	2.01	✓
SR16	51.07	14.27	27.42	4.72	35.53	2.01	✓
SR17	50.32	14.25	27.31	4.71	35.52	2.01	✓
SR18	50.87	14.28	27.4	4.72	35.52	2.01	✓
SR19	55.36	14.41	28.39	4.74	35.52	2.03	✓
SR20	51.5	14.26	27.52	4.71	35.52	2.02	✓
SR21	50.72	14.25	27.37	4.71	35.52	2.01	✓
SR22	50.98	14.26	27.43	4.71	35.52	2.01	✓
SR23	60.77	14.55	29.46	4.77	35.51	2.05	✓
SR24	55.95	14.48	28.57	4.76	35.51	2.05	✓
Criteria	**50**	**25**	**25**	**8**	**90**	**4**	

Appendix A Emissions Estimation

A.1 Emission Estimation Equations

The major air emission from extraction activities is fugitive dust. Emission factors can be used to estimate emissions of TSP, PM_{10} and $PM_{2.5}$ to the air from various sources. Emission factors relate the quantity of a substance emitted from a source to some measure of activity associated with the source. Common measures of activity include distance travelled, quantity of material handled, or the duration of the activity.

The National Pollutant Inventory Emission Estimation Technique Manual for Mining (January 2012) provide the equations and emission factors to determine the emissions of TSP and PM_{10} from mining and quarrying activities. These emission factors incorporate emission factors published by the USEPA in their AP-42 documentation.

Excavation on Overburden

The default emission rates in the NPI EET for Mining have been used for this emission factor, where:

TSP = 0.025 kg/t

PM_{10} = 0.012 kg/t

$PM_{2.5}$ = 10.5% of TSP is $PM_{2.5}$

Bulldozer on Material other than Coal

The default emission rates in the NPI EET for Mining have been used for this emission factor where:

TSP = 17 kg/hr

PM_{10} = 4.1 kg/hr

$PM_{2.5}$ = 10.5% of TSP is $PM_{2.5}$

Material Unloading

Emission rate for dust from stockpile has been calculated using the following emission rates from AP42 11.19.2:

TSP = PM_{10} multiplied by 2

PM_{10} = default of 0.00005

$PM_{2.5}$ = 15% of PM_{10} is $PM_{2.5}$

Crushing and Screening

The default emission rates in the NPI EET for Mining and AP42 11.19.2 have been used.

Drilling

The default emission rates in the NPI EET for Mining and have been used for these emission factors. 10% PM_{10} is $PM_{2.5}$. 100 holes per day is the estimated rate.

Blasting

The TSP emission rate for blasting has been calculated using the following equation:

$$Emissions_{TSP} = 0.00022 \, x \, Area \, blasted \, (m^2)^{1.5} \text{ kg /blast}$$

PM_{10} is TSP multiplied by 0.47 and 10% of PM_{10} is $PM_{2.5}$. Area blasted is 900 m^2 with 1 blast per weekday of operation.

Haul Roads

The default emission rates in the NPI EET for Mining and have been used for these emission factors, where:

TSP = 4.23 kg/VKT

PM_{10} = 1.25 kg/VKT

$PM_{2.5}$ = 17% of TSP is $PM_{2.5}$

Stockpile Loading

Emission rate for dust from stockpile has been calculated using the following emission rates from AP42 11.19.2:

TSP = PM_{10} multiplied by 2

PM_{10} = 0.00005

$PM_{2.5}$ = 15% of PM_{10} is $PM_{2.5}$

Wind Erosion

The default emission rates in the NPI EET for Mining and have been used for these emission factors, where:

TSP = 0.4 kg/ha/hr

PM_{10} = 0.2 kg/ha/hr

$PM_{2.5}$ = 10.5% of TSP is $PM_{2.5}$

A.2 Activity Overview

Tables A-1 and A-2 summarise the emission factors and key parameters applied in the emissions estimation.

Table A-1: Source Type Emission Factors applied

Source type	Default TSP Emission factor	Derived TSP Emission factor	PM_{10}/TSP ratio	$PM_{2.5}$/TSP ratio	Units	Controls applied
Pit Activities						
Excavator on Overburden	0.025	-	0.47	0.105	kg/t	Water sprays, 50%
Dozer on overburden	17	-	0.20	0.105	kg/t	Water sprays, 50%
Blasting/drilling:						
Drilling	0.59	-	0.52	0.052	kg/hole	Water sprays, 70%
Blasting	-	6.24	0.47	0.047	kg/blast	No control
Wind erosion:						
stockpiles/pits/haul roads	0.4	-	0.5	0.075	kg/ha/h	Water sprays, 50%
Processing & Handling:						
Primary Crushing	0.01	-	0.40	0.083	kg/t	Water sprays, 50%
Secondary Crushing	0.03	-	0.40	0.083	kg/t	Water sprays, 50%
Screening	0.08	-	0.75	0.023	kg/t	Water sprays, 50%
Loading stockpiles	0.004	-	0.5	0.075	kg/t	No control
Unloading stockpiles	0.03	-	0.35	0.02	kg/t	Water sprays, 50%
Wheel generated dust:						
Unpaved roads	4.23	-	0.22	0.02	kg/VKT	Watering Level 2 + speed limit < 40 km/h (86%)

Table A-2: Parameters applied in emissions estimation

Parameter ID	Value	Units	Description	Data source
U	3.3	m/s	mean wind speed	BoM meteorological data
W	33	t	Truck capacity	client supplied
p	60	days	rainfall > 0.25mm	BoM meteorological data
f	17.1	%	% time winds > 5.4m/s	BoM meteorological data
Holes	100	Holes/day	Holes drilled per day	Client supplied
A	900	m^2/blast	Area blasted	Default
B	1	Blast/day	Blasts per day	Client supplied
s	7.9	%	Silt content	Default
M	6.9	%	Moisture	Default
t	1,980	t/day	Maximum material moved	Client supplied
a	73,400	m^2	Area of land subject to wind erosion	Client supplied

Operating Hours

Extraction and processing of material has been modelled as 7 am to 6 pm on weekdays and 7 am to 1 pm on Saturdays.

Haul Roads

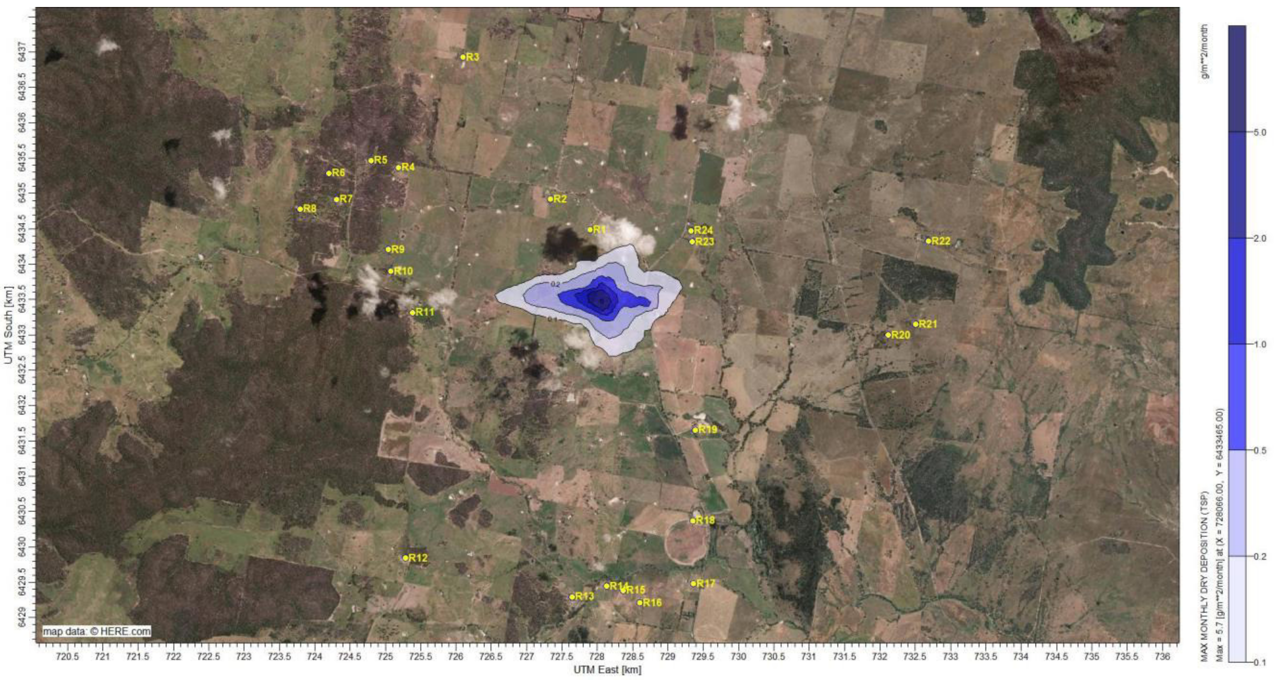
Haul road locations provided and incorporated into the model are summarised below.

Total Haul Road	Modelled Parameter (km)	VKT (laden + unladen)
External	0.8	8.7 VKT/h
Internal	0.6	6.6 VKT/h

Appendix B Contour Plots

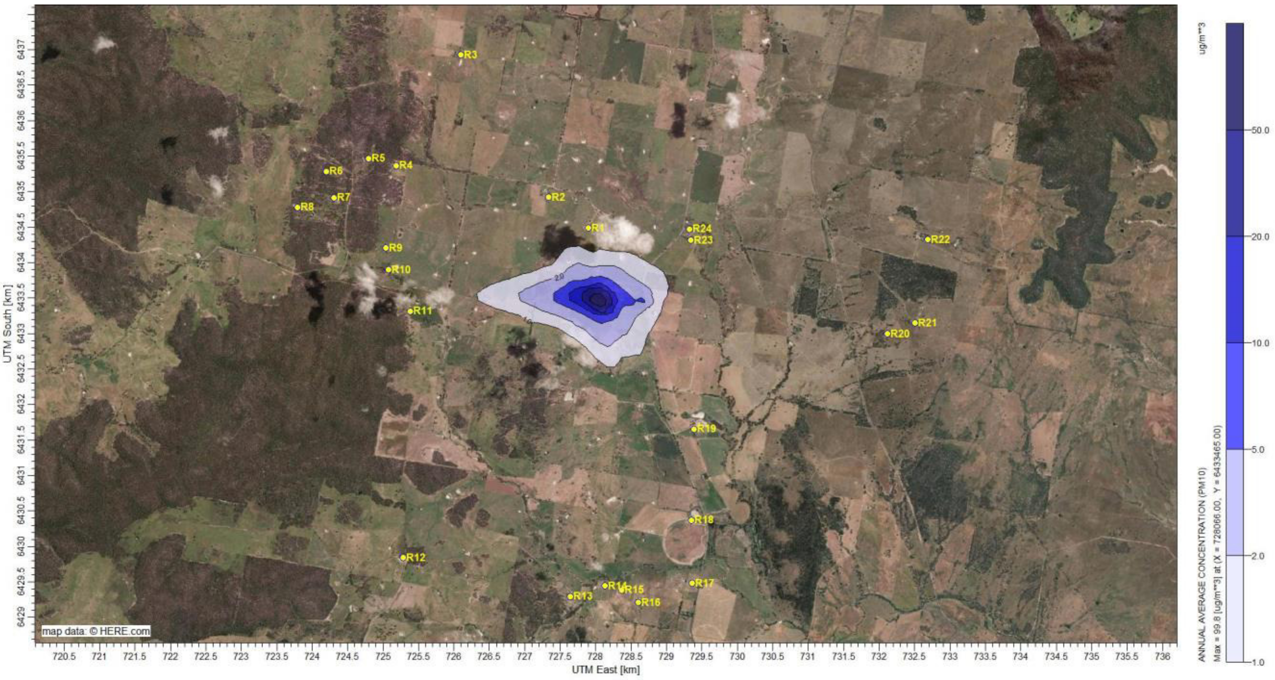
The contour plots are created from the predicted ground-level concentrations at the network of gridded receptors within the modelling domain at frequent intervals. These gridded values are converted into contours using triangulation interpolation in the CALPOST post-processing software within the CALPUFF View software (Version 10.0.0).

Contour plots illustrate the spatial distribution of ground-level concentrations across the modelling domain for each time period of concern. However, this process of interpolation causes a smoothing of the base data that can lead to minor differences between the contours and discrete model predictions.



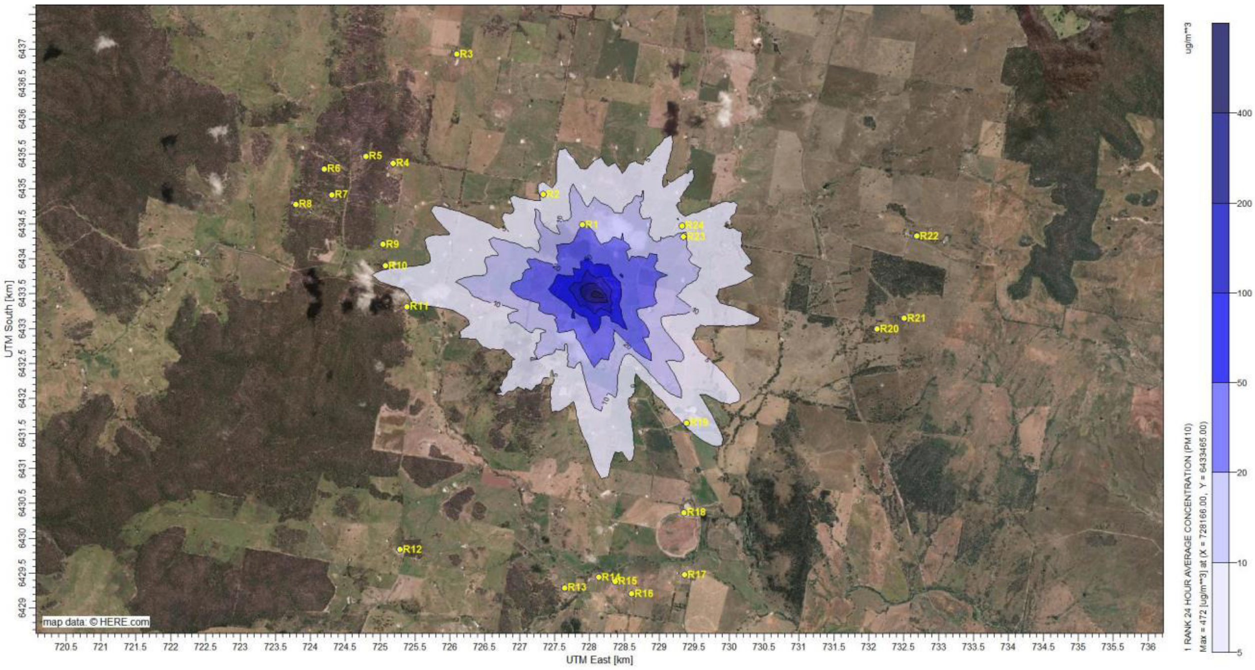
Pollutant: Dust Deposition	Averaging Period: Month	Percentile: 100th	Criteria: 2 g/m^2/month

Comment:
Incremental



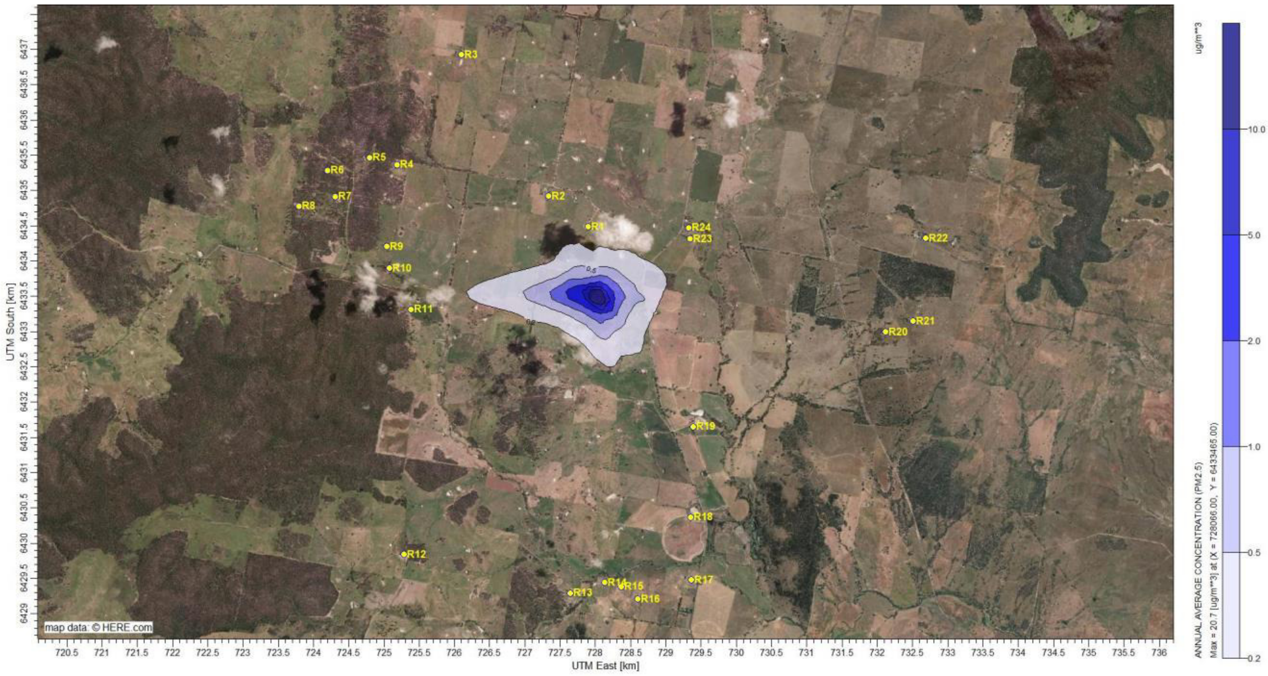
Pollutant:	Averaging Period:	Percentile:	Criteria:
PM_{10}	Annual	100^{th}	25 $\mu g/m^3$

Comment:
Incremental



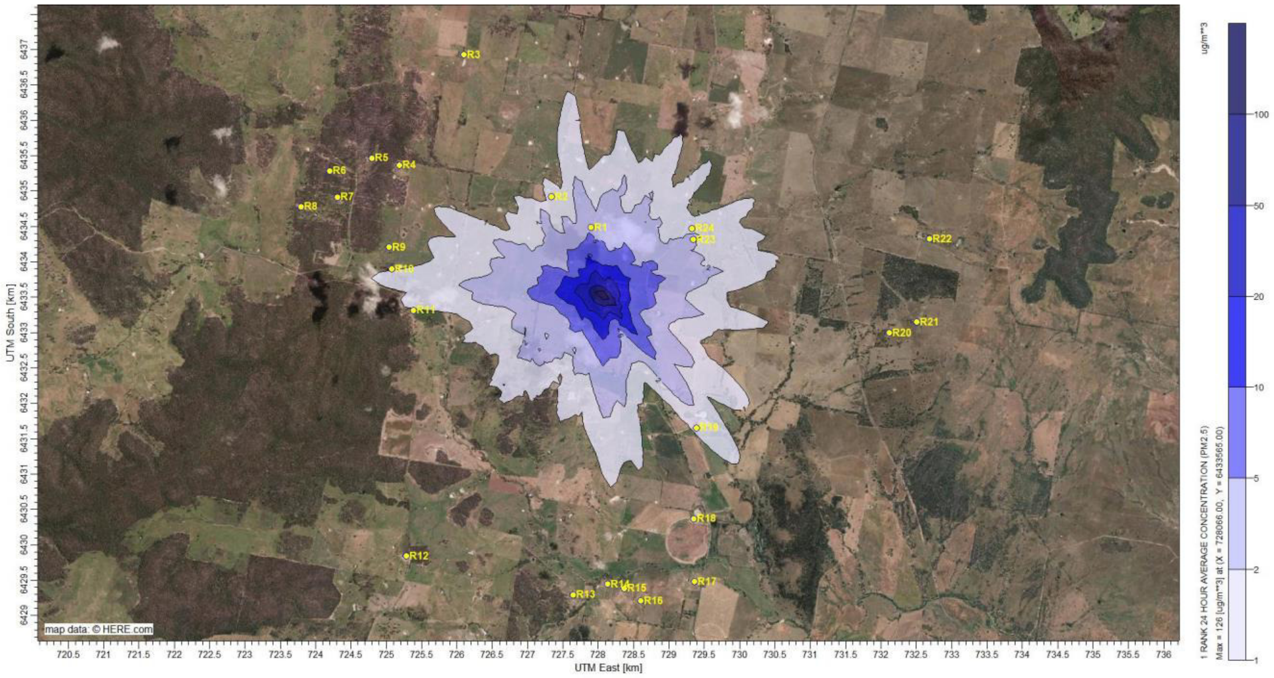
Pollutant: PM_{10}	**Averaging Period:** 24 Hour	**Percentile:** 100^{th}	**Criteria:** 50 µg/m^3

Comment:
Incremental



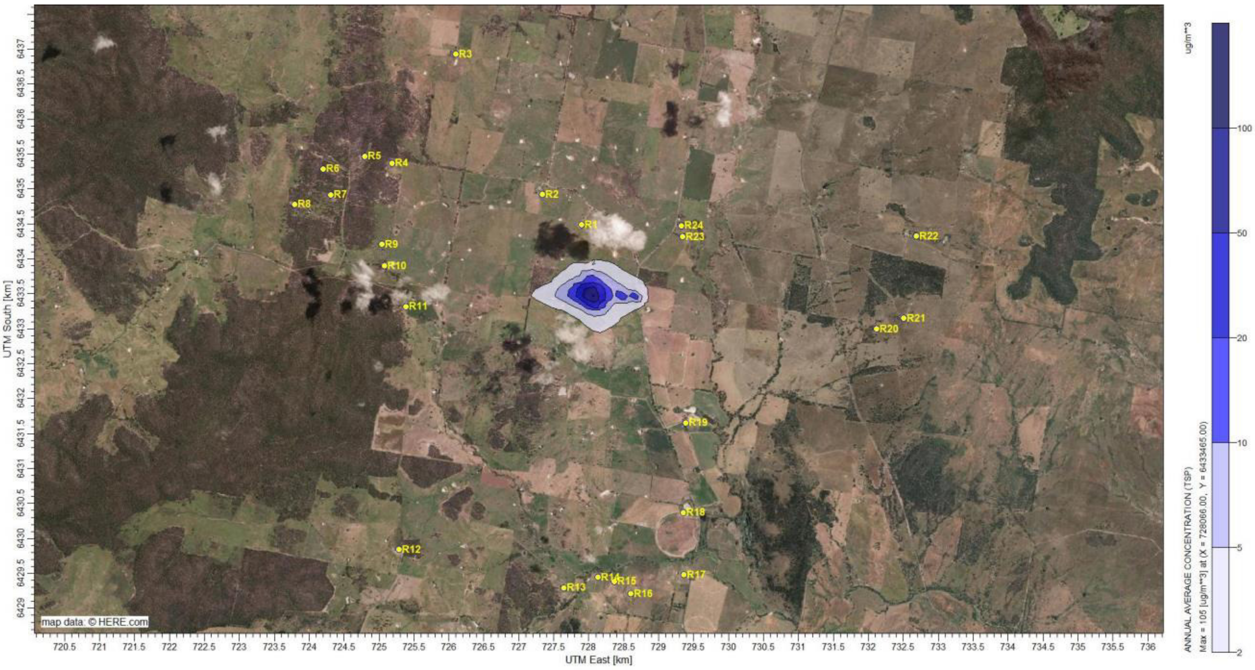
Pollutant:	Averaging Period:	Percentile:	Criteria:
$PM_{2.5}$	Annual	100th	8 µg/m^3

Comment:
Incremental



Pollutant:	Averaging Period:	Percentile:	Criteria:
$PM_{2.5}$	24 Hour	100^{th}	25 µg/m^3

Comment:
Incremental



Pollutant:	Averaging Period:	Percentile:	Criteria:
TSP	Annual	100th	90 µg/m^3

Comment:
Incremental